SACRAMENTO

NARRATIVE END ITEM REPORT
SATURN S-IVB-505N

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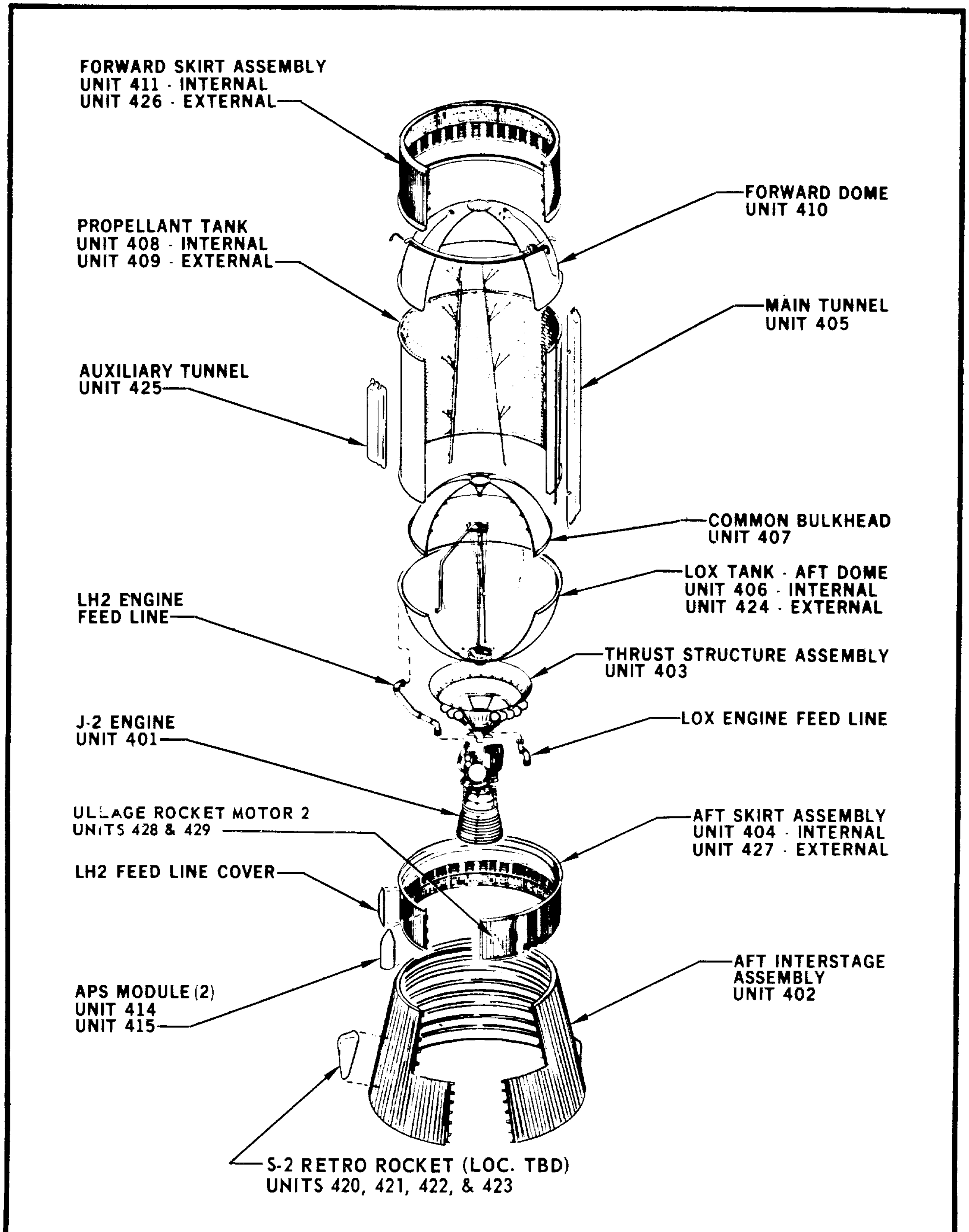


Exploded View of S-IVB Stage for Saturn V

ABSTRACT

The Narrative End Item Report (NEIR) contained herein is a narrative summary of the McDonnell Douglas Astronautics Company - Western Division (MDAC-WD), Sacramento Test Center test records relative to the Saturn S-IVB-505N Flight Stage (MDAC-WD, P/N 1A39300-509, S/N 1010).

Narrations are included on those conditions related to permanent nonconformances which were generated during the manufacturing cycle and existed at the time of the Sacramento Test Center (STC) acceptance testing. The report sets forth data pertinent to total time or cycle accumulation on time or cycle significant items. Data relative to variations in flight critical components are also included. There is no provisions to update or revise the NEIR after the initial release.

Descriptors

NEIR	Significant Items
Documentation	Stage Checkout
Configuration	Prefire, Postfire, and Poststorage

PREFACE

This Narrative End Item Report is prepared by the Reliability Assurance Directorate of the McDonnell Douglas Astronautics Company - Western Division, for the National Aeronautics and Space Administration under Contract NAS7-101. This report is presented in response to requirements of NPC 200-2, Paragraph 14.2.4, and is issued in accordance with MSFC-DRL-021, Contract Data Requirements, which details the contract data required from the MDAC-WD. The report summarizes the period from the initial stage acceptance testing at the MDAC-WD Sacramento Test Center, Rancho Cordova, California, through turnover to the MDAC Florida Test Center, Cape Kennedy, Florida.

The previous period of stage acceptance testing at the MDAC-WD Space Systems Center, Huntington Beach, California, and transfer to the MDAC-WD Sacramento Test Center, was covered by Narrative End Item Report, Saturn S-IVB-505N, Douglas Report DAC-56574, dated September 1967.

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

APPENDIX I

APPENDIX II

APPENDIX III

SECTION 1
INTRODUCTION

1.0 INTRODUCTION

1.1 Scope

The NEIR compiles quality evidence and assessments of a particular end item for use in evaluating program objectives and end item usage. This report narrates upon the Saturn S-IVB Stage, and discusses the following:

a. Configuration at turnover for shipment to the Florida Test Center, Cape Kennedy, Florida.

b. Replacements made during Sacramento Test Center (STC) test and acceptance checkout, including serial number of articles removed or substituted.

c. Nature of problems and malfunctions encountered.

d. Corrective action taken or pending.

e. Extent of retests or tests not completed.

f. Total operating hours or cycles for each time or cycle significant item.

1.2 Format

This document is organized into sections, with each section fulfilling a specific purpose. The title of each section and a brief outline of its purpose follow:

SECTION:

1. INTRODUCTION. This section discusses the scope of the NEIR, the Stage Design Concept, Documentation, and Turnover Data.

2. NARRATIVE SUMMARY. A brief discussion of the principle test areas is presented to give management personnel a concise view of successful test achievement, and remaining areas of concern.

3. STAGE CONFIGURATION. Conformance to engineering design, and data on time/cycle significant items.

4. NARRATIVE. A presentation of checkout operations presented in the chronological order of testing. Failure and Rejection

1.2 (Continued)

Reports (FARR's) are referenced as applicable for each paragraph.

Appendices:

I Testing Sequence

Graphic presentation of the order and activity dates of the checkout procedures.

II Nonconformance Tables

a. Table I. A compilation of FARR's initiated during prefire checkout.

b. Table II. A compilation of FARR's initiated during countdown and postfire checkout.

c. Table III. A compilation of FARR's initiated during poststorage checkout.

d. Table IV. A compilation of FARR's initiated during postmodification retest.

III Flight Critical Items

The flight critical items (FCI) installed on the stage at the time of turnover to NASA/STC for shipment to KSC.

1.3 Stage Functional Description

A detailed system analysis is beyond the scope of this report. The "S-IVB Stage End Item Test Plan," 1B66684, contains a description of each operational system and includes a listing of test procedures, with the objective and prerequisite of each test. The stage is primarily a booster stage consisting of propellant tanks, feed lines, electrical and pneumatic power for operation of stage systems, and such systems as are required for checkout purposes, fuel loading and unloading control, in-flight control and pressurization, and data measurement during these operations.

1.4 Documentation

Manufacturing and test records for this stage include Fabrication Orders (FO's), Assembly Outlines (AO's), Inspection Item Sheets (IIS's), Failure and Rejection Reports (FARR's), Serial Engineering Orders (SEO's), Radiographic Inspection Records, Vehicle Checkout Laboratory (VCL) test data, and vendor data. FO's and AO's record in sequence all manufacturing processes, procedures, and Quality Control inspection activities. Any problem or discrepancy noted by Inspection and Test personnel is recorded on an IIS for corrective action. Any discrepancy from a drawing requirement is recorded on a FARR by Inspection and Test personnel. The FARR is also used to record the Material Review Board (MRB) disposition applicable to the discrepancy. SEO's may be written to define the rework required by a FARR; to change the effectivity of a drawing; or to change other drawing requirements. Radiographic Inspection Records and X-ray photographs of all weld seams are maintained on file by the contractor. All original data is retained in the contractor's Reliability Assurance Directorate Central Data Files. Vendor technical data is received on functional purchased parts and also retained in Central Data Files. The majority of the documentation referenced within this report is included in the log book which accompanies the stage.

1.5 Turnover

Turnover of the stage was made on 30 November 1968, at the MDAC-WD Sacramento Test Center. Final acceptance was made by the Air Force Quality Assurance Division Representative, by DD250 (packing sheet #SM-41078-1). Two letters, A3-131-5.4.3.18-L-5338 dated 20 November 1968, and A45-870-L054 dated 26 November 1968, from the MDAC-WD management to the NASA Resident Manager

1.5 (Continued)

at Sacramento Test Center submitted the documentation necessary to effect turnover. Copies of these letters and the accompanying documentation is included in the stage log book. Acceptance of the Auxiliary Propulsion Modules was effected on the same DD250, as noted previously for the stage. However, those units were shipped to KSC separately, and were noted as shortage items on the stage DD250.

SECTION 2

NARRATIVE SUMMARY

2.0 NARRATIVE SUMMARY

The following paragraphs present a narrative summary of stage checkout of the S-IVB-505N stage. Stage prefire tests, postfire tests, poststorage tests, and stage postmodification retest checkout conducted at the Sacramento Test Center (STC) are summarized in paragraphs 2.1, 2.2, 2.3, and 2.4 respectively. The Final Inspection, Weight and Balance, and Preshipment Preparations are summarized in paragraphs 2.5, 2.6, and 2.7 respectively. More detailed narrations on these tests and operations are presented in section 4.

Paragraph 2.8 summarizes any tests that were invalidated or not completed prior to stage transfer, and any retesting that will be required. Paragraph 2.9 summarizes the incomplete failure and rejection reports that were transferred open at the time of stage transfer from STC to MSFC/FTC.

2.1 Stage Prefire Acceptance Tests

The S-IVB stage acceptance test program, conducted at the Sacramento Test Center (STC), verified the functional capabilities of the stage systems, at sea level conditions, during static acceptance firing. The stage acceptance firing plan, 1B71775 A, delineated the general philosophies of the STC test programs. Test request 1048 authorized the acceptance firing and delineated the test objectives and requirements. The stage prefire checkouts were designed to ensure a condition of readiness for the stage, facility, and GSE to conduct a successful static acceptance firing program.

2.1 (Continued)

The stage was received at the STC on 17 August 1967. The prefire checkouts began on 22 August 1967 and were concluded on 9 October 1967. Twenty-four procedures were exercised to ensure the functional capabilities of the stage. Detailed narrations on the prefire checkouts are presented in paragraph 4.1.

Prefire checkouts began with the prefire structural inspection, which was successfully completed without the generation of FARR's; however, there were five revisions to the procedure.

The forward skirt thermoconditioning system checkout, the umbilical interface compatibility check, the APS interface compatibility check, hydraulic system setup and operation, and the common bulkhead vacuum system checks were successfully conducted without generating any FARR's. However, a total of 25 revisions were written against these procedures. Two revisions were against the forward skirt thermoconditioning system. Three revisions were against the umbilical interface compatibility checks. Eleven revisions were against the hydraulic system setup and operation procedure. Nine revisions were against the common bulkhead vacuum system checks.

Preliminary propulsion leak and functional checks were successfully completed after the incorporation of twenty-four revisions. Two FARR's were generated as a result of this checkout.

Power was applied to the stage for the first time on 7 September 1967, with the initiation of the stage power setup procedure. A second issue was

2.1 (Continued)

required due to the generation of one FARR and it was successfully demonstrated on 11 September 1967. The stage power turnoff procedure was successfully demonstrated on 12 September 1967 with the second issue. The first issue was unsuccessful due to the FARR generated during the stage power setup. Four revisions were written against the stage power setup procedure. Three revisions were written against the stage power turnoff procedure.

The EBW system checkout, the APS checkout, and the stage and GSE manual controls check were successfully demonstrated without generating any FARR's. Three revisions were written against the stage and GSE manual controls procedure, and one revision was written against the EBW system checkout. No revisions were written against the APS procedure.

The cryogenic temperature sensor verification was successfully concluded, with three revisions to the procedure. No FARR's were generated.

Verification of the telemetry and range safety system checks required the issuance of two procedures, because of an out-of-tolerance VSWR problem generated during DDAS automatic. Although there were twelve revisions to the first issue and nine revisions to the second issue, there were no FARR's generated.

Power distribution system checks were successfully conducted without generating any FARR's. There were seven revisions written against the procedure. The range safety system was successfully demonstrated, after writing two revisions. There were no FARR's generated as a result of this test.

2.1 (Continued)

The DDAS calibration was successfully completed without generating any FARR's. There were four revisions written against this procedure. The propellant utilization system calibration was successfully completed, without the generation of FARR's; however, it was necessary to write three revisions against the procedure.

The level sensor and control unit calibration was successfully completed, after writing one revision to the procedure. No FARR's were generated as a result of this test.

The propellant utilization system was successfully demonstrated, after one revision was incorporated. There were no FARR's generated as a result of this test. The propulsion system automatic check was successfully demonstrated, after forty-six revisions were incorporated in the test. No FARR's were written as a result of this test.

The digital data acquisition system checks were successfully completed, after the incorporation of thirteen revisions to the procedure. There were two FARR's written as a result of this test.

The integrated system test was successfully conducted without the generation of FARR's; however, there were thirty-one revisions to the procedure.

The final prefire propulsion system leak check was successfully conducted without encountering any major problems that resulted in the generation of FARR's. It was necessary however, to write fifteen revisions to the procedure.

2.1 (Continued)

The stage was ready for the simulated static firing on 4 October 1967, and the "Ready for Acceptance Firing" milestone was met on 6 October 1967.

The acceptance firing test, designated countdown 614092, was initiated on 10 October 1967, and was terminated after 448 seconds of successful main-stage operation. A detailed narrative of the acceptance firing is delineated in Douglas Report SM-47461, dated December 1967.

2.2 Stage Postfire Checkout

Contract Change Order 1418 delineated an abbreviated postfire checkout in lieu of the checkout required by paragraph 5.5.2.4 of SM-41412, General Test Plan. The following is a brief recap of the abbreviated postfire checkouts accomplished per Test Request 1048, on Test Stand Beta I.

The abbreviated postfire checkout following completion of acceptance firing was initiated on 13 October 1967, with the successful demonstration of the stage power setup and turnoff procedures. There were no discrepancies recorded by FARR's for either procedure. One revision was recorded in the procedure for stage power setup and one recorded for stage power turnoff.

The propulsion system leak check was conducted from 16 through 18 October 1967, to determine leakage which could have resulted from the stage acceptance firing. No unacceptable leakages were detected, and two FARR's were initiated; one against a shorted thermocouple in the LH2 low pressure duct, which was replaced, and one against a leak of the seal between the start

2.2 (Continued)

tank and the fill valve, which was accepted by the Material Review Board. Twenty revisions were required to satisfactorily complete the procedure.

The integrated systems test (IST) procedure was conducted on 13 October 1967, for a data evaluation comparison with the prefire IST, as required by Contract Change Order 1418. There were no FARR's generated as a result of the postfire IST; however, thirty-one revisions were required to complete the procedure.

The postfire structural inspection was conducted from 16 through 18 October 1967, to verify that static firing was not detrimental to the stage structure, and to provide a comparison with the prefire structural inspection results. There was one FARR reported on tears in the LH2 tank forward dome mylar covering which was repaired per drawing requirements. There were seven revisions recorded in the procedure.

The postfire operation and securing procedure for the hydraulics system was conducted on 16 October 1967, to secure the system and prepare it for shipment to the VCL for extended storage. There were no problem areas resulting in FARR documentation, and no revisions were written.

The final prestorage postfire procedure conducted was the forward skirt thermo-conditioning system checkout. This prepared the thermoconditioning system for shipment to the VCL for storage preparation. No FARR's were initiated, but one revision was recorded in the procedure.

2.2 (Continued)

The stage was removed from the test stand on 28 November 1967, and transferred to the VCL for storage preparations.

2.3 Stage Poststorage Acceptance Tests

The stage was removed from storage and installed in Test Stand Beta I on 14 March 1968, for the first poststorage checkout. A special coldflow and cold helium system leakcheck, designated countdown 614101, was initiated on 1 May 1968 and successfully concluded on 2 May 1968. A detailed narrative of the coldflow, conducted per test request 1050, is delineated in Douglas Report SM-47461A, dated September 1968. The first checkout of the stage systems on Beta I started on 14 March 1968, and was completed on 25 June 1968. The stage was removed from the Test Stand on 25 June 1968, and sent to VCL for further modification. Twenty-eight H&CO's involving the stage systems were performed during these checkouts; however, the majority of these H&CO's required more than one issue and are combined within one narration. Detailed narrations on the poststorage checkouts are presented in paragraph 4.3.

Poststorage checkouts began with structural inspection, which was successfully completed after two issues. There were no discrepancies recorded for the initial poststorage issue of the procedure prior to coldflow; however, two FARR's were initiated during post coldflow inspection and there were ten revisions written against both issues.

Prior to turning on the stage power at Beta I, checks were made of the stage wiring, the cryogenic temperature sensor verification, the umbilical

2.3 (Continued)

interface wiring, the forward skirt thermoconditioning system, the APS interface compatibility check, and the manual controls. No significant problems were encountered during this period and no FARR's were initiated as a result of these checkouts. Procedure revisions were written to correct minor problems.

Power was first applied to the stage on 11 April 1968, with the initiation of the stage power setup and turnoff procedures. A second issue was required to verify proper talkback of the LOX tank nonpropulsive vent closed indication, which had malfunctioned during the initial test. The second issue was successfully demonstrated on 22 April 1968. The final demonstration was conducted after the coldflow on 6 May 1968. There were no major problems, although several procedure revisions were required to correct minor problems.

The propulsion system leak checks were run concurrently with the electrical systems tests during April and May 1968. A number of leaks were found, and those exceeding allowable limits were corrected. FARR A270657 documented five leaks associated with the LOX nonpropulsive vent system. The leaks were eliminated by seal replacement and smoothing operations on the sealing surfaces.

The DDAS calibration required three issues. The first issue was successfully accomplished on 17 April 1968; however, due to replacement of the PCM/DDAS assembly a second issue was conducted on 7 May 1968. The third

2.3 (Continued)

and final issue was required on 27 May 1968 to checkout a new RASM which malfunctioned during the DDAS automatic system test on 27 May 1968. FARR A261659 written during the final test indicated an inflight calibration failure due to noise imposed by grounding and wire routing. The condition was accepted without rework.

The power distribution system test was conducted twice during poststorage operations on 18 April and 8 May 1968, before and after the stage coldflow operations.

The hydraulic system setups were successfully completed, after writing eighteen revisions to the procedure. No FARR's were generated as a result of this test.

The propellant utilization system required two attempts due to replacement of the PUEA. This part replacement also necessitated a second issue of the propellant utilization system automatic test. A third issue of PU automatic was required due to an operator's error during the second attempt.

The propellant system automatic checkout was accomplished twice, both before and after the stage coldflow test. During the final test, the mainstage OK pressure switch number 1 gave an out-of-tolerance indication. The switch was removed and replaced on FARR 500-226-315.

The DDAS automatic checkout was conducted four times during poststorage testing. The first issue was modified to accomodate the coldflow test. Replacement of the PCM/DDAS per FARR A270665 during stage power setup on

2.3 (Continued)

30 April 1968, necessitated a repeat of the initial test prior to the cold-flow. The third and fourth issues were conducted in support of the all systems test.

The signal conditioning setup, the exploding bridgewire automatic checkout, the APS system checkout, the APS automatic checkout, and the level sensor and control unit calibration were each accomplished by one issue.

The hydraulic system automatic checkout was initially conducted on 14 May 1968 and was repeated on 15 May 1968, to verify that the digital data tape coefficient changes for the pitch and yaw position parameters corrected the out-of-tolerance measurements recorded during the initial test.

The range safety receiver check was successfully accomplished on 14 May 1968; however, the range safety system automatic test required two issues, on 14 May and 15 May 1968. The second issue was required because the O2H2 burner shutdown responses were not properly performed during the first issue.

The all systems test was performed three times during the coldflow and poststorage operations. The first issue was accomplished on 5 June 1968. The second issue, requiring two attempts, due to replacement of the PCM RF transmitter per FARR 500-225-271, was accepted on 14 June 1968.

The hydraulic system operating and securing procedure, to obtain closed loop hydraulic fluid samples and to secure the system prior to removal of the stage from the test stand, was accomplished on 6 June 1968.

2.3 (Continued)

The forward skirt thermoconditioning system checkout was initiated on 7 June 1968, and successfully completed on 26 June 1968. The final operations consisted of disconnecting and securing the servicer and preparing the stage TCS for stage transfer and shipment.

During the AST, the PCM RF assembly was replaced on FARR 500-225-271. The replacement resulted in the issuance of the telemetry and range safety antenna system checkout, which was accomplished on 12 June 1968.

Because the LH_2 tank was entered during this period, it was necessary to reverify the cryogenic temperature sensors located in this tank. A cryogenic temperature sensor verification procedure was performed to accomplish this, with only the LH_2 tank sensors involved. No problems were encountered during this final checkout.

2.4 Post Modification Retest

The stage was removed from Test Stand Beta I and sent to the VCL on 25 June 1968 for modifications. On 5 August 1968, the stage was installed on Test Stand Beta III to continue modifications. The modifications were completed on 22 October 1968, and the post modification retest operations were started on 23 October 1968, with the initiation of the propulsion system leak checks, and were successfully completed by the performance of the forward skirt thermoconditioning system checkout on 21 November 1968. Twenty-six H&CO's involving the stage systems were performed during these checkouts; however, several of these H&CO's required more than one issue and are combined within one narration. Detailed narrations on the post modification checkouts are presented in paragraph 4.4.

2.4 (Continued)

Post modification retest began with the propulsion system leak checks on 23 October 1968. The leak checks were run concurrently with the electrical systems tests during October and November 1968. A number of leaks were noted, and those exceeding allowable limits were corrected. FARR 500-489-421 reported that the pneumatic actuation latch, P/N 1B66639-515, S/N 045, was leaking excessively. FARR 500-489-286 removed and replaced the LOX prevalve.

The forward skirt thermoconditioning system checkout performed the steps required to prepare the stage thermoconditioning system for use. Manual control capability of the pneumatic regulators and valves was verified by the manual controls checkout.

The umbilical interface compatibility check ensured that the proper loads were present on all power buses and that all control circuits for the propulsion valves and safety items were within prescribed tolerances. This was followed by the auxiliary propulsion system interface compatibility checkout, which performed the same type of test for the APS control system components and the APS engine valves.

Power was applied to the stage on 29 October 1968, by the performance of stage power setup. This procedure required four attempts as the first two tests were aborted due to incorrect stage wiring in the switch selector. The third attempt, subsequent to correction of the stage wiring, was aborted due to a test operator's error. The fourth attempt on 30 October 1968, was successfully completed with the exception of several valves that did not

2.4 (Continued)

give closed talkback indication. These apparent malfunctions were due to the valves not being electrically connected. Proper valve operation was demonstrated during subsequent tests. The satisfactory performance of the stage power turnoff procedure was demonstrated successfully on 29 October 1968.

The power distribution system checkout, and the hydraulic system setup and operating procedure were both accomplished with no operational difficulties. During the hydraulic system checkout, FARR 500-489-618 reported that both the yaw and pitch actuators were scratched in the area of the actuator lock grooves. The scratches were polished out, no retests were required as the hydraulic system was not invalidated by the rework.

Signal conditioning setup was accomplished on 30 October 1968 by the calibration of three 5 volt excitation modules, nine 20 volt excitation modules, one temperature bridge, four hydraulic pressure transducers, one expanded scale monitor module and thirty-eight strain gauges. FARR 500-489-502 reported that pin "N" of module, P/N 1A84763-511, S/N 0151 was bent and that cable assembly, P/N 1B76206-1, had a damaged insert on plug P3. The bent pin was straightened and the damaged plug was removed and replaced. FARR 500-489-316 stated that the strain gauge module, P/N 1B68859-503, S/N 040, would not indicate a reading lower than 0.06 vdc. After replacement of the module, a retest of that circuit completed this procedure.

The auxiliary propulsion system checkout, the digital data acquisition system calibration, the exploding bridgewire system checkout, the post-

2.4 (Continued)

modification structural inspection, the level sensor and control unit calibration procedure, the propellant utilization system calibration, and the propellant utilization system automatic checkout were accomplished between 31 October 1968 and 7 November 1968, without any discrepancies.

The cryogenic temperature sensor verification was accomplished twice during post modification operations. The first issue, conducted on 4 November 1968 and accepted on 25 November 1968, was performed as a part of the structural inspection. The final issue, accomplished and accepted on 27 November 1968, was necessitated by removal of the LH2 probe for cleaning.

The hydraulic system checkout, the propulsion system automatic system test, the digital data acquisition system checkout, and the telemetry and range safety antenna system check were accomplished with no FARR's generated as a result of the tests. The hydraulic system checkout also secured the stage hydraulic system in preparation for stage shipment.

The propulsion system automatic checkout verified the operation capability of the stage electro-mechanical propulsion system. The test was initiated on 9 November 1968, and accepted on 12 November 1968. No test discrepancies were noted during this test.

The digital data acquisition system test required three attempts. The first and second attempts were unsatisfactory as several parameters were not verified due to stage configuration. The third attempt was successfully completed on 20 November 1968. FARR 500-489-332 reported a faulty GH2

2.4 (Continued)

injector pressure transducer, and also provided the instructions to remove and replace the transducer.

The range safety receiver checks were initiated on 11 November 1968, after the fourth attempt. The first attempt was aborted due to a faulty microdot generator. The second attempt was terminated after it was noted that the test code plugs were not installed on the decoder assemblies. Run three was invalidated by the replacement of the range safety system 2 receiver per FARR 500-489-383.

The FM/FM and single sideband (SSB) telemetry system test was conducted from 11 November through 15 November 1968, to verify the capability of the system to properly transmit stage vibration and acoustical data. Complete system verification was not accomplished because of schedule requirements for stage shipment to the FTC. Refer to paragraph 4.4.24 for a description of problem areas which affected the system's verification.

The range safety system automatic checkout, initiated on 12 November 1968 was accepted on 15 November 1968, on the second attempt. The first attempt was completed on 12 November 1968, but was not acceptable due to the cables on the exploding bridgewire firing units 1 and 2 being reversed.

The final postmodification checkout was the forward skirt thermoconditioning system test, initiated on 18 November 1968 and accepted on 21 November 1968. A final GN2 purge was conducted to dry and prepare the system for stage shipment.

2.5 Final Inspection

Following the final manufacturing operations and modifications, the final inspection of stage 505N was accomplished between 20 November 1968 and 27 November 1968, to locate and correct any remaining stage discrepancies. A total of three hundred fourteen mechanical and electrical area discrepancies were recorded during the inspection, mostly of a minor nature. All except five of these discrepancies were cleared to an acceptable condition without requiring failure and rejection report action. The remaining thirty-one problems were noted on FARR's 500-489-570, 500-489-669, and 500-608-293, and were acceptably corrected. FARR 500-488-131 dealing with a crack in the Korotherm insulation was transferred open to the FTC. A more detailed narration on the final inspection is presented in paragraph 4.5.

2.6 Weight and Balance

The stage was rotated to a horizontal position in preparation for the weight and balance operation. On 28 November 1968 the stage was weighed by means of a three point electronic weighing system. Three electronic load cells, one aft and two forward, measured the reaction forces of the otherwise unsupported stage. The reaction force measurements were then used to determine that the stage shipping and handling weight was 27,556.0 pounds, the stage weight corrected for Standard Gravity in a vacuum was 27,609.3 pounds, and the stage longitudinal center of gravity was located at station 330.3. Paragraph 4.6 presents a more detailed narration on this operation.

2.7 Preshipment Purge

The final operation before the stage was shipped to FTC was the preshipment purge. Gaseous nitrogen was used to purge the stage systems to dewpoints of -30.0°F for the LH2 system, and -33.0°F for the LOX system. The proper desiccants were installed to maintain the proper stage environment during the air transport operations. Paragraph 4.7 presents a more detailed narration on this operation.

2.8 Incomplete Tests and Retesting Requirements

All required prefire, poststorage, and postmodification retest stage checkouts were accomplished during the stage testing period.

During the period following the stage testing, modifications were made to the stage prior to shipment from STC, and additional modifications were scheduled at FTC. These modifications invalidated parts of the previously accomplished stage testing, including stage power setup, DDAS automatic, range safety receiver checks, propellant utilization system, propulsion system leak and functional checks, propulsion system automatic, APS propulsion system test, and the all systems test. MDAC report DAC-61233, dated 2 December 1968, extensively covered these modifications and the retesting that would be required at FTC to reverify the affected stage systems. This report was prepared in accordance with contract change order CCO 1977.

2.9 Incomplete FARR's

Four FARR's were not closed at the time stage 505N was shipped to FTC, and

2.9 (Continued)

these FARR's were transferred open with the stage. FARR 500-488-131 reported a crack in the Korotherm insulation near the LH2 chilldown pump. FARR 500-226-447, written against the LH2 tank not overfill sensor was accepted for use at the STC, but was to be resubmitted at FTC for final disposition. FARR 500-489-634 removed a discrepant vibration multiplexer, P/N 1B32686 -509, S/N 02. Final disposition and part replacement will be accomplished at the FTC. FARR 500-489-693 reported that the combustion dome vibration transducer output was at 0 vpp and should have been 1.4 ± 0.5 vpp. Final disposition will be accomplished at the FTC.

SECTION 3
STAGE CONFIGURATION

3.0 STAGE CONFIGURATION

The paragraphs of this section define the configuration of the stage, and note the applicable variations. Paragraph 3.1 discusses the means used to verify the stage configuration; paragraph 3.2 describes those flight critical items which deviate from the stage design; and paragraph 3.3 contains those variations in stage configuration which represent changes in the scope of the program.

A listing, in tabular form, of all time/cycle significant items on the stage, along with the accumulated time/cycles for each item, is included in paragraph 3.4.

Existing contractual configuration control papers are referenced wherever possible.

3.1 Design Intent Verification

This configuration of the stage is defined in the Engineering Configuration List (ECL), Space Vehicle, Model DSV-4B-1-1, Manufacturing Serial Number 1010, revision C, dated 24 June 1968. This ECL document includes a listing of all parts, non-hardware drawings, and manufacturing and process specifications required for the manufacture and test of the stage, as defined by Engineering production drawings and EO releases. The ECL has been transmitted to NASA under a separate cover.

Verification of design intent was accomplished by comparing the ECL with the Planning Configuration List (PCL), and the Reliability Assurance Department As-Built Configuration List (ABCL). Any discrepancies found were resolved by the contractor, and a listing of the resultant action is filed at the contractor's facility.

3.2 Stage Variations - Flight Critical Items

Identification of components and assemblies which are variations to the stage design is accomplished by including the serial engineering order (SEO) dash number after the part number. Those flight critical items which are installed in the stage with SEO variations are reviewed in this paragraph. A description of the variation, along with part number and serial number, is presented for each part.

3.2.1 LOX and LH_2 Fill and Drain Valves

SEO 1A48240-007 authorized the removal of the existing bonded insert and O-ring from the electrical connectors, leak testing of the receptacles, and subsequent installation of an unbonded insert and O-ring for the LOX and LH_2 fill and drain valves, P/N 1A48240-505, S/N's 0044 and 0127, respectively. The unbonded inserts were installed to minimize cracking of the inserts and glass insulation at cryogenic temperatures, in accordance with NASA Change Order 1602.

3.2.2 Oxidizer Mass Probe

SEO 1A48430-011 was a salvage SEO for reworking and cleaning the oxidizer mass probe, P/N 1A48430-509, S/N D9. Due to improper probe assembly, silicone O-rings, which are not LOX compatible, were found in some LOX tanks.

3.2.3 Fuel Mass Probe

SEO 1A48431-009 provided salvage instructions for the fuel mass probe, P/N 1A48431-513, S/N D4, due to defective spot welds discovered by the vendor, Honeywell, during assembly of other probes, P/N's 1A48431-501 and -505. Rework substituted a riveted attachment in place of the welded assembly.

3.2.4 LH_2 Chilldown Shutoff Valve

SEO 1A49965-012 authorized unbonded insert replacement for the bonded insert, as previously described in paragraph 3.2.1, for the LH_2 chilldown shutoff valve, P/N 1A49965-523, S/N 0506.

3.2.5 LOX Chilldown Shutoff Valve

SEO 1A49965-013B authorized the removal of the valve assembled with Drilube 822, which was no longer LOX compatible, and the installation of LOX chilldown shutoff valve, P/N 1A49965-525, S/N 0507, which was assembled with an acceptable lubricant.

3.2.6 Hydraulic Pitch and Yaw Actuator Assemblies

SEO 1A66248-011A reworked the hydraulic pitch and yaw actuator assemblies, P/N 1A66248-505, S/N's 51 and 53, by cleaning per MSFC-SPEC-237A, priming per MIL-P-23377, and top coating per MIL-C-22750A. This was done because the aluminum parts on the actuator might have been subjected to stress corrosion.

3.2.7 Chilldown Inverter Electronic Assembly

SEO 1A74039-011E authorized special rework and testing to verify the low temperature integrity of the chilldown inverters, P/N 1A74039-517, S/N's 00037 and 00039.

3.2.8 O_2H_2 Burner Assembly

SEO 1B62600-012 authorized reworking the O_2H_2 burner assembly, P/N 1B62600-527, S/N 08, to update it to provide restart capabilities.

3.2.9 Actuation Control Modules

SEO 1B66692-A45-1 authorized correction of electrical designations stamped in error on the actuation control modules, P/N 1B66692-501, S/N's 24, 25, 26, 27, 32, 33, 35, 84 and 85.

3.3 Scope Change/Engineering Change Proposal Verification

Scope Changes (SC) and Engineering Change Proposals (ECP), with the applicable verification data, are listed in Form DD829-1, which is included in the Stage Log Book. This paragraph lists those SC/ECP's which were verified at STC or subsequent to stage turnover to NASA. Those SC/ECP's which were incorporated and verified prior to transfer of the stage to the STC were covered in the DAC-56574 NEIR.

The following SC/ECP's were incorporated subsequent to stage transfer from the SSC and were substantiated as being incorporated by MDAC and AFQA personnel "buy off" of the AO paper. The SC/ECP's are listed as previously complied with (PCW) on Form DD829-1.

a. ECP X126, authorized by CCO's 511, 551, 578, and 607, and letter S-IVB-5-293, provided for modification of the cryogenic repressurization system.

b. ECP X132, authorized by CCO's 383, 422, 435, 508, and 516, and letter S-IVB-5-581, provided for an operational telemetry system.

c. ECP X171, authorized by CCO's 79 and 582, provided for MC fittings and flared tubing.

d. ECP X181, authorized by CCO's 642, 651, 659, and 743, and letters SD-L-864, S-IVB-5-858, S-IVB-5-9-55, S-IVB-6-221, and S-IVB-65-173, provided for implementation of the cryogenic repres urization system.

e. ECP X204, authorized by CCO's 650, 661, 670, and 708, and letter S-IVB-65-246, provided for the deletion of the pad safety and minimum liftoff pressure switches.

3.3 (Continued)

f. ECP X218-R1, authorized by CCO's 742, 772, and letter S-IVB-5-1425, provided for modifications of the LH_2 tank forward dome and the LOX tank aft dome.

g. ECP X222, authorized by letter SD-L-1470 and technical directive TD-66-1, provided for the modification of the LOX tank propellant utilization probe.

h. ECP X226, authorized by CCO 690, provided for Apollo coordinate system standards.

i. ECP X255, authorized by CCO 645 and letter S-IVB-6-518, provided for the thermal insulation of Model II switch selectors.

j. ECP X259, authorized by technical directive TD-66-16, provided for the modification of the LH_2 tank probe.

k. ECP X262, authorized by CCO's 813 and 853, and letter S-IVB-6-198, provided for the modification of the emergency detection system cutoff circuits.

l. ECP X267, authorized by letter L-131-66, provided for the identification of GFE test code plugs.

m. ECP 0277, authorized by CCO 801, provided for the deletion of the interstage propellant dispersion system pyrotechnics.

n. ECP 0281, authorized by letters L-192-66 and L-380-66, provided for the relocation of stage coolant system plumbing to ensure proper mating with the NASA Instrumentation Unit (I.U.).

o. ECP 0304, authorized by CCO 977 and letters S-IVB-6-886 and S-IVB-6-1050, provided for the deletion of S-IVB vent termination pressure switches.

p. ECP 0443-1-R1, authorized by CCO 1045 and letter S-IVB-6-541, provided for the installation of hazardous gas detection lines.

q. ECP 0481, a compatibility ECP, revised the Hi-Lok attachment in the aft skirt separation ring.

r. ECP 0488, a compatibility ECP, provided for the installation of an ullage pressure transducer in the forward dome.

s. ECP-0493-R2, a compatibility ECP, provided for the redesign of the chilldown shutoff valves.

3.3 (Continued)

t. ECP 0533, a compatibility ECP, provided for the installation of temperature and pressure transducers on the hydraulic accumulator/reservoir.

u. ECP 0542, authorized by letter S-IVB-6-874, provided for changes to the Model II PCM RF assembly.

v. ECP 0557-R2, a compatibility ECP, provided for the redesign of the APS helium pressure regulator.

w. ECP 0565, a compatibility ECP, provided for the redesign of the fill and drain valve.

x. ECP 0581-R1, authorized by letter S-IVB-6-1341, provided for the redesign of the fuel injection temperature bypass command circuit.

y. ECP 0590, a compatibility ECP, provided for the substitution of the multiplexer and selector switch shrouds with aluminized mylar shrouds.

z. ECP 0592-R3, a compatibility ECP, provided for rework of the APS pressurization system and associated support equipment.

aa. ECP 0600, a compatibility ECP, provided for the rework of the engine drive high pressure check valve.

ab. ECP 0601, authorized by CCO 993, changed the self locking bolts to bolts and nuts that could be lockwired.

ac. ECP 0605, a compatibility ECP, provided for the installation of EDS isolator vibration transducer brackets.

ad. ECP 0613-R1, authorized by letter S-IVB-6-1176, provided for the replacement of hydraulic hose support bracket bolts.

ae. ECP 0630, a compatibility ECP, provided for the reconfiguration of the LOX inlet duct.

af. ECP 0633, a compatibility ECP, provided for the rework of the LH_2 propellant duct resilient mount.

ag. ECP 0634, authorized by letter S-IVB-6-1215, provided for the revision of the EDS circuit.

ah. ECP 0638-R1, authorized by letter S-IVB-6-1262, provided for the replacement of the APS quick-disconnect.

3.3 (Continued)

ai. ECP 0639, a compatibility ECP, provided for the relocation of the transducers for measurements D2, D3, D4, and D105.

aj. ECP 0648-R1, authorized by letter S-IVB-6-1327, provided for the deletion of the relief valve function from the ambient helium fill module.

ak. ECP 0651, a compatibility ECP, provided for the core reset resistor for the chilldown inverter.

al. ECP 0653, a compatibility ECP, revised the stage umbilical panel markings.

am. ECP 0663, a compatibility ECP, provided for the reconfiguration of the LH_2 -503 inlet duct.

an. ECP 0672, a compatibility ECP, provided for the reconfiguration of the pneumatic power control module.

ao. ECP 0677, authorized by CCO 1104, provided for the redundant start relay for the 70 pound ullage engine.

ap. ECP 0680, authorized by letter S-IVB-6-1380, provided for the inverter-converter 21 vdc measurement.

aq. ECP 0681, authorized by letter S-IVB-7-680, provided for the check-out of spare depletion sensors.

ar. ECP 0685, a compatibility ECP, provided for the replacement of the accumulator/reservoir support.

as. ECP 0686, a compatibility ECP, provided for the replacement of the LH_2 depletion sensor time delay module.

at. ECP 0689, a compatibility ECP, provided for the redesign of the vent and relief valves in the seal areas of the open position actuators and in the area of the boost close piston installation.

au. ECP 0699, a compatibility ECP, provided for the LOX ullage sensing line purge.

av. ECP 0801, a compatibility ECP, provided for LH_2 pressurization module strap rework.

aw. ECP 0944-R2, authorized by CCO 1240, provided for the modification of the forward skirt thermoconditioning supply line supports.

3.3 (Continued)

ax. ECP 0953-R1, a compatibility ECP, provided for the addition of ullage rocket jettison system confined detonating fuse clamps.

ay. ECP 0983-R1, a compatibility ECP, provided for LOX chilldown shutoff valve LOX compatibility.

az. ECP 0984-R1, a compatibility ECP, provided for battery ground strap replacement.

ba. ECP 1008, authorized by letter S-IVB-S-1406, provided for the redundant EDS J-2 engine cutoff modifications.

bb. ECP 2019-R1, a compatibility ECP, provided for the redesign of the continuous vent system.

bc. ECP 2027, a compatibility ECP, provided for the replacement of the feedthrough coaxial socket contacts.

bd. ECP 2033, a compatibility ECP, provided for the redesign of the pneumatic power control module and the engine pump purge module pipe assemblies.

be. ECP 2037, a compatibility ECP, provided for the main hydraulic pump compensator attachment.

bf. ECP 2040, authorized by letter I-CO-S-IVB-7-100, provided for additional measurements in the S-IVB stage operational measurement program.

bg. ECP 2046, a compatibility ECP, provided for the relocation of the pressure transducers for measurements D16, D183, and D184.

bh. ECP 2048-R1, authorized by CCO 1198, provided for the modification of the continuous vent module bypass valve hardwire talkback.

bi. ECP 2049-R2, a compatibility ECP, provided for procurement and installation of pneumatic actuation control module, P/N 1B66692-501.

bj. ECP 2051, a management directive ECP, provided for the reconfiguration of the cold helium dump module.

bk. ECP 2061, a compatibility ECP, provided for auxiliary hydraulic pump seal replacement.

bl. ECP 2073, a compatibility ECP, provided for the painting of the hydraulic actuators to relieve stress corrosion.

3.3 (Continued)

bm. ECP 2079, authorized by CCO's 1231 and 1318 and letter S-IVB-7-1029, provided for the rain baffles for the environmental control system vents.

bn. ECP 2090, authorized by letter 2-403-67, provided for the redesign of the directional control valve.

bo. ECP 2092, a compatibility ECP, provided for the replacement of bus connectors.

bp. ECP 2096, authorized by CCO 1198, provided for the modification of the continuous vent system.

bq. ECP 2117-R1, a compatibility ECP, provided for the addition of a check valve in the actuation control module.

br. ECP 2128-R1, authorized by CCO 1399 and CCO 1566, provided for the reconfiguration of the pneumatic power control module, P/N 1A58345.

bs. ECP 2132, a compatibility ECP, provided for replacing the dc-dc converter in the PCM RF assembly, Model II.

bt. ECP 2133, authorized by letter S-IVB-7-183, provided for incorporation of RFI filters in the PCM RF assembly, Model II.

bu. ECP 2134, authorized by CCO 1170, provided for replacement of channel cards for the model 270 multiplexers.

bv. ECP 2169, a compatibility ECP, provided for relocation of the telemetry common bulkhead pressure sensing port.

bw. ECP 2175, a compatibility ECP, provided for a LOX chilldown pump purge bypass line and orifice.

bx. ECP 2176-R1, a compatibility ECP, provided for the rerouting of coaxial cables.

by. ECP 2184, a compatibility ECP, provided for the replacement of the fuel low pressure feed duct aluminum burst disc.

bz. ECP 2189, a compatibility ECP, provided for rework of the LH_2 PU probe spotwelds.

ca. ECP 2193, a compatibility ECP, provided for the replacement of the NAS 1351 passivated screws in the aft skirt.

3.3 (Continued)

cb. ECP 2204-R2, a compatibility ECP, provided for the removal of a relief valve from the repressurization control module.

cc. ECP 2214, authorized by CCO 1278, provided for the addition of instrumentation for the new temperature measurement, C0016.

cd. ECP 2226-R1, a compatibility ECP, provided for modification of the PU electronics circuitry to prevent erroneous LH_2 excess mass readings.

ce. ECP 2234-R2, a compatibility ECP, provided for reconfiguration of the fuel relief valve.

cf. ECP 2235-R1, a compatibility ECP, provided for replacement of the 2 amp relays, P/N 1B50992-1, with relays, P/N 1B50992-505.

cg. ECP 2242, a compatibility ECP, provided for modification of the PU component oven to incorporate high reliability transistors.

ch. ECP 2244, a compatibility ECP, provided for reconfiguration of the pneumatic power control module.

ci. ECP 2247, a compatibility ECP, provided for insulation of the static inverter heat sink.

cj. ECP 2248, a compatibility ECP, provided for modification of the continuous vent module.

ck. ECP 2249, a compatibility ECP, provided for rework of the APS propellant control modules.

cl. ECP 2252, a compatibility ECP, provided for the replacement of a check valve in the cold helium dump module.

cm. ECP 2265, a compatibility ECP, provided for replacement of the flexible couplings, P/N 1B38430-1, with couplings, P/N 1B38430-501, in the forward skirt environmental control system.

cn. ECP 2269, a compatibility ECP, provided for reconfiguration of the fuel and LOX chilldown shutoff valves.

co. ECP 2270-R1, a compatibility ECP, provided for special tests of the chilldown inverters.

cp. ECP 2271, authorized by CCO 1280, provided for the lengthening of the IU electrical ground cable.

3.3 (Continued)

cq. ECP 2277-R2, authorized by CCO 1530, provided for replacement of ambient helium spheres for the repressurization system and pneumatic control system with in-house manufactured vessels.

cr. ECP 2279, a compatibility ECP, provided for sealant at the forward skirt mating surfaces for the range safety and telemetry antennas.

cs. ECP 2292, a compatibility ECP, provided for diode module insulating washers.

ct. ECP 2298-R1, authorized by CCO 1680, provided for incorporation of the emergency vent valve for the J-2 Engine start tank.

cu. ECP 2304, authorized by CCO 1352 and 1383, provided for reconfiguration of the LH_2 chilldown system supply duct.

cv. ECP 2308, authorized by CCO's 1352 and 1383, provided for the design of a fuel duct vacuum valve locking device.

cw. ECP 2309, authorized by CCO's 1352 and 1383, provided for the reconfiguration of the LH_2 chill system supply duct.

cx. ECP 2311-R2, authorized by CCO 1522, provided for modification of the LH_2 pressurization system.

cy. ECP 2312, a compatibility ECP, provided for the replacement of the servo bridge transmission motor.

cz. ECP 2360, authorized by letter S-IVB-7-1136, provided for the replacement of the 2 amp relay, P/N 1A93619, by relay, P/N 1B39033.

da. ECP 2419-R1, a compatibility ECP, provided for the replacement of the solenoid on the continuous vent modules, P/N's 1B67193-503 and -505.

db. ECP 2434, authorized by CCO's 1410 and 1494, provided for the qualification certification of the J-2 engine to stage attach bolts.

dc. ECP 2454, authorized by CCO 1430, provided for test and checkout requirements at KSC.

dd. ECP 2485-R2, authorized by CCO 1562, provided for the modification of the RASM division module.

de. ECP 2640-R1, authorized by CCO 1717, provided for a modified fuel vent directional control valve to minimize stress corrosion.

3.3 (Continued)

df. ECP 2642-R1, authorized by CCO 1654, provided for a modified cold helium dump module with improved internal springs.

dg. ECP 2787-R1, authorized by letter I-CO-S-IVB-8-287, provided for addition of suppression diodes across the safe and arm device command lines.

dh. ECP 2790-R1, a compatibility ECP, provided for inspection of Korotherm insulation thickness per revised tolerances.

di. ECP 2793, a compatibility ECP, provided for the Saturn V helium fill module thermal protection.

dj. SC 1383A, authorized by letter I-CO-SD-4-1616, provided for installation of calibratible pressure switches (Calips).

3.4 Time/Cycle Significant Items

Twenty-nine items installed on the stage are time/cycle significant as defined by design requirements drawings 1B55423, Government Furnished Property Time/Cycle Significant Items, and 1B55425, Reliability Time/Cycle Significant Items. The following table lists these items, along with the time/cycles accrued on each at the time of stage transfer to FTC, and the maximum allowable limits prescribed by Engineering.

Part Number and Part Name	Serial Number	Accumulated Measurement	Engineering Limit
Reliability Items (1B55425 R).			
1A48858-1 Helium Storage Sphere	1012	9 cycles	50 cycles
	1127	7 cycles	50 cycles
	1132	6 cycles	50 cycles
	1139	6 cycles	50 cycles
	1146	6 cycles	50 cycles
	1160	7 cycles	50 cycles
	1161	6 cycles	50 cycles
	1164	6 cycles	50 cycles
	1167	6 cycles	50 cycles

3.4 (Continued)

Part Number and Part Name	Serial Number	Accumulated Measurement	Engineering Limit
1A49421-507	207	4.66H	100 hours cryogenic
		0.7 min	40 minutes dry
		3 cycles	10 cycles (dry starts)
1A49423-509 LOX Chilldown Pump	1388	0.7 hours	20 hours
1A59562-509 PU Bridge Potentiometer	5006	437 cycles	5,000 cycles
	5008	386 cycles	5,000 cycles
1A66241-511 Auxiliary Hydraulic Pump	X454588	18.9 hours	120 hours
		110 cycles	300 cycles
1B57731-501 Control Relay Package	417	109 cycles	100,000 cycles
	418	93 cycles	100,000 cycles
G.F.P. Items (1B55423 H)			
40M39515-113 EBW Firing Unit	277	56 firings	1,000 firings
	282	57 firings	1,000 firings
	283	56 firings	1,000 firings
	285	57 firings	1,000 firings
40M39515-119 EBW Firing Unit	450	60 firings	1,000 firings
	451	58 firings	1,000 firings
50M10697 Command Receiver	172	43.6 hours	2,000 hours
	195	10.1 hours	2,000 hours
50M10698 Range Safety Decoder	091	50.3 hours	2,000 hours
	0124	12.9 hours	2,000 hours
50M67864-5 Switch Selector	157	71,326 cycles	250,000 cycles

3.4 (Continued)

		Part Number and Part Name	Serial Number	Accumulated Measurement	Engineering Limit
103826		J-2 Engine	J-2091		
	a.	Customer connect lines and inlet ducts		28.44% *	250-10,000 cycles
	b.	Gimbal bearing		24.65% *	250-10,000 cycles
	c.	Firing time		1071.9 seconds	3,750 seconds
	d.	Helium Regulator (P/N 558100-91)	4086582	17 cycles	None Given

* This data includes all engine gimbal cycles at STC, plus cycles brought forward from Rocketdyne records. The cycle data is expressed as a percent of design limits based on the gimbal angle, and can vary from 250 to 10,000 + cycles as noted. The indicated percentages were computed from the Engine Log Records utilizing the graph per Rocketdyne Rocket Engine Data Manual R-3825-1.

SECTION 4
NARRATIVE

4.0 NARRATIVE

The paragraphs of this section narrate upon the stage checkout in the chronological order of testing. The major paragraphs comprising the narrative are: 4.1, Stage Prefire Checkout; 4.2, Stage Postfire Checkout; 4.3; Stage Poststorage Checkout, 4.4, Post Modification Retest; 4.5, Final Inspection; 4.6, Weight and Balance; and 4.7, Preshipment Preparations. Each major paragraph is subdivided to the degree required to present a complete historical record of stage checkout.

Nonconformance and functional failures affecting the stage are recorded on FARR's, and are referred to by serial numbers throughout the section (e.g., FARR A255228 and 500-024-135). The referenced FARR's are also presented numerically by serial number in Appendix II.

4.1 Stage Prefire Checkout

Stage prefire checkouts began on 22 August 1967, with initiation of the prefire structural inspection, paragraph 4.1.1. The stage prefire checkouts were completed on 9 October 1967, with completion of the final prefire propulsion system leak check, paragraph 4.1.24. All tests required per End Item Test Plan 1B66684, change K dated 20 September 1968, were activated and completed.

4.1.1 Structural Prefire Inspection (1B40654 B)

Performed between 22 August 1967, and 12 September 1967, this inspection verified that transportation of the stage from the Space System Center to the Sacramento Test Center had no detrimental effect on the structure: it also established the condition of the stage prior to static acceptance firing, for comparison with the stage condition subsequent to a full duration static firing program.

Prior to rotating or moving the stage from the horizontal position in which it was shipped, the area between the forward skirt and the forward dome was visually inspected and determined to be free of debris.

After completion of stage installation into the test stand, the forward access kit and the protective cover kit were installed. The thrust structure access doors, P/N 1A68531-3 and P/N 1B68531-4, were removed to facilitate inspection of the thrust structure area. The main and auxiliary tunnel fairing covers; the LH_2 feed line fairing assembly, P/N 1B28109; the fill, drain, and chill system fairing assembly, P/N 1B28110; the LH_2 chilldown pump line fairing assembly, P/N 1B28111; and the chill system return fairing assembly, P/N 1B28112, were removed to facilitate the inspection in the respective areas.

A visual inspection was performed on all adhesive bonded parts for voids, unbond or broken conditions, and all metal to metal bond continuity was verified by the coin tap method as prescribed in DPS 32330.

A visual inspection of the ambient helium storage spheres was accomplished to determine if any out-of-tolerance ding, scratch or finish discrepancy existed.

4.1.1 (Continued)

A radiographic inspection of the forward and aft "V" section (the junction of the forward skirt and the forward dome, and the junction of the thrust structure and the aft dome), revealed four pieces of foreign material in the aft section: One huck bolt, 0.325 by 3/4 inch, and one aluminum shaving, 5/16 inch long by 0.115 inch diameter, and two tubular shaped pieces of aluminum, 1/4 inch long by 0.125 inch diameter. All items were removed prior to the initial pressurization of the propellant tanks.

Five revisions were made to facilitate inspection of the stage and were as follows:

a. Two revisions were required to update the procedure.

b. Two revisions deleted steps that were accomplished per the installation procedure.

c. One revision deleted a step no longer required.

There were no other deviations or failure and rejection reports noted, and the procedure was certified as complete and acceptable on 12 September 1967.

4.1.2 Umbilical Interface Compatibility Check (1B64316 D)

Prior to connecting the forward and aft umbilical cables for automatic power-on checks, this manual checkout provided the test sequences which were used to check the design specifications and the continuity of the stage umbilical wiring. Accomplished by point-to-point resistance checks of all umbilical circuits, this test ensured that the proper loads were present on all power buses, and that the control circuit resistances for the propulsion valves and safety items on the stage were within the prescribed tolerances.

This procedure was accomplished on 6 September 1967, and was accepted on the same date. A series of resistance checks were made at specified test points on the signal distribution unit, P/N 1A59949-1, using test point terminal 463A1A5-J43FF as the common test point for all measurements. These measurements verified that all wires and connections were intact and of the proper material and wire gauge, and that all resistance values and loads were within the design requirement limits. The test points, circuit functions, measured resistances, and resistance limits are shown in Test Data Table 4.1.2.1.

Engineering comments indicated that all parts were installed at the start of this procedure. No problems or malfunctions were encountered during the procedure, and no FARR's were written. Three revisions were made to the procedure for the following:

a. One revision corrected an error in the procedure.

b. Two revisions increased the upper tolerance limits of two steps to match circuit changes.

4.1.2.1 Test Data Table, Umbilical Interface Compatibility Check

Reference Designation 463A2

Test Point	Function	Meas. Ohms	Limit Ohms
A2J29-C	Cmd., Ambient Helium Sphere Dump	30	10-60
CB-8-2	Cmd., Engine Ignition Bus Pwr Off	Inf	Inf
CB-9-2	Cmd., Engine Ignition Bus Pwr On	13.5	5-100
CB-10-2	Cmd., Engine Control Bus Pwr Off	Inf	Inf
CB-11-2	Cmd., Engine Control Bus Pwr On	14.5	5-100
A2J29-N	Cmd., Engine He Emerg Vent Control On	55	10-60
A2J29-P	Cmd., Fuel Tnk Repress He Dump Vlv Open	38	10-60
A2J29-Y	Cmd., Start Tnk Vent Pilot Vlv Open	22	10-60
CB-4-2	Cmd., LOX Tank Cold He Sphere Dump	34	10-60
A2J29-c	Cmd., LOX Tnk Repress He Sphere Dump	39	10-60
A2J29-h	Cmd., Fuel Tnk Vent Pilot Vlv Open	58	60 max
	(Same, reverse polarity)	Inf	500k min
A2J29-i	Cmd., Fuel Tnk Vent Vlv Boost Close	6	40-100
	(Same, reverse polarity)	Inf	500k min
A2J29-q	Cmd., Amb He Supply Shutoff Vlv Close	24	10-60
A2J30-H	Cmd., Cold He Supply Shutoff Vlv Close	1.2k	1.5k max
	(Same, reverse polarity)	Inf	Inf
A2J30-W	Cmd., LOX Vent Valve Open	70	10-70
	(Same, reverse polarity)	Inf	500k min
A2J30-X	Cmd., LOX Vent Valve Close	65	10-70
	(Same, reverse polarity)	Inf	500k min
A2J30-Y	Cmd., LOX & Fuel Prevlv Emerg Close	70	100 max
	(Same, reverse polarity)	Inf	Inf
A2J30-Z	Cmd., LOX & Fuel Chilldown Vlv Close	70	10-70
	(Same, reverse polarity)	Inf	500k min
A2J42-F	Meas. Bus +4D111 Regulation	170	6 min
A2J35-y	Meas. Bus +4D141 Regulation	Inf	3 min
A2J6-AA	Sup. 28v Bus +4D119 Talkback Power	105	60-120

Reference Designation 463A1

A5J41-A	Meas. Bus +4D131 Regulation	150	20 min
A5J41-E	Meas. Bus +4D121 Regulation	2.25k	1.6k min
A5J53-AA	Sup. 28v +4D119 Fwd Talkback Pwr	79	60-100

4.1.3 Forward Skirt Thermoconditioning System Checkout (1B41955 B)

Prior to initiating the prefire automatic checkout of the stage at STC, the forward skirt thermoconditioning system (TCS) was functionally checked to prepare it for operation and to verify that the system was capable of supporting stage checkout operations. The procedure utilized the thermoconditioning servicer, P/N 1A78829-1, which conditioned and supplied the water/methanol heat transfer fluid to the forward skirt TCS, P/N 1B38426-513.

Checkout of the TCS was accomplished from 6 through 9 September 1967, and was verified as acceptable on 10 September 1967. Preliminary operations included setup and connection of the servicer to the TCS, and inspection of the TCS panels for open equipment mounting bolt holes and properly torqued bolts. The TCS was pressurized to 32 ±1 psig, with freon gas, and leak checked with the gaseous leak detector, P/N 1B37134-1. The areas checked for leakage included all TCS B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold bellows. No leakage was detected.

The TCS was purged with gaseous nitrogen; then, water/methanol fluid was circulated through the system. Water/methanol samples were taken from the fluid sample pressure valve (system inlet) and the fluid sample return valve (system outlet), and checked for cleanliness, specific gravity, and temperature. Particle counts for each micron range were well within the acceptable cleanliness limits specified. The specific gravity and temperature of the fluid were measured with a hydrometer and thermometer, respectively, determining that the water/methanol concentration was within the acceptable mixture range (delta P testing band).

4.1.3 (Continued)

A differential pressure test was conducted to verify correct system geometry and proper flow distribution. The test was accomplished by measuring the differential pressure between the TCS inlet and outlet ports, as well as the inlet and outlet temperatures, while maintaining a water/methanol flow rate of 7.8 $\pm$0.2 gpm. The differential pressure was recorded as 15.1 psid while inlet and outlet temperatures were 61°F and 64°F, respectively.

The final step consisted of the TCS operation with the servicer at the required temperatures, pressures, and flow rate while visually checking for the leakage of all water lines, internal piping, and supply and return lines to the TCS. No leakage was detected. The TCS operation demonstrated that the system was prepared to support prefire checkout activities on the test stand.

Two revisions to the procedure were recorded during checkout operations:

a. One revision deleted a part number callout for a hose assembly, P/N 1B38536-1, to agree with the test stand configuration.

b. One revision corrected an error in the procedure.

4.1.4 APS Interface Compatibility Checkout (1B49558 B)

Initiated, accomplished, and accepted on 6 September 1967, this manual checkout specified and provided instructions for compatibility and continuity test requirements that were performed subsequent to installation of the auxiliary propulsion system (APS) simulators, P/N 1B56715-1, and prior to the operational checkout of stage systems pertinent to APS circuitry.

The check was started with a visual inspection of all plugs and connectors involved in this test for bent or broken pins and/or other physical defects. Proper connection between the control relay package, the aft skirt components, and the APS simulators was verified by point-to-point resistance measurements as shown in Test Data Table 4.1.4.1.

There were no shortages or interim use material items installed at the start of this test, nor were any revisions made to the procedure. No FARR's were generated as a result of this test.

4.1.4.1 Test Data Table, APS Interface Compatibility

Common Test Point: Stage Ground

Test Point			Component Nomenclature	Meas. Ohms	Limit Ohms
404A51A4	J4	A	414A8L1 Eng. 1 Valve A	26	25 ± 5
404A51A4	J4	B	414A8L5 Eng. 1 Valve 1	26	25 ± 5
404A51A4	J4	C	414A8L2 Eng. 1 Valve C	26	25 ± 5
404A51A4	J4	D	414A8L6 Eng. 1 Valve 3	26	25 ± 5
404A51A4	J4	E	414A8L3 Eng. 1 Valve B	26	25 ± 5
404A51A4	J4	F	414A8L7 Eng. 1 Valve 2	26	25 ± 5
404A51A4	J4	G	414A8L4 Eng. 1 Valve D	26	25 ± 5
404A51A4	J4	H	414A8L8 Eng. 1 Valve 4	26	25 ± 5
404A51A4	J4	J	414A10L1 Eng. 3 Valve A	26	25 ± 5
404A51A4	J4	K	414A10L5 Eng. 3 Valve 1	26	25 ± 5
404A51A4	J4	L	414A10L2 Eng. 3 Valve C	26	25 ± 5
404A51A4	J4	M	414A10L6 Eng. 3 Valve 3	26	25 ± 5

4.1.4.1 (Continued)

Test Point			Component Nomenclature	Meas. Ohms	Limit Ohms
404A51A4	J4	N	414A10L3 Eng. 3 Valve B	26	25 ± 5
404A51A4	J4	P	414A10L7 Eng. 3 Valve 2	26	25 ± 5
404A51A4	J4	R	414A10L4 Eng. 3 Valve D	26	25 ± 5
404A51A4	J4	S	414A10L8 Eng. 3 Valve 5	26	25 ± 5
404A51A4	J4	T	414A9L1 Eng. 2 Valve A	26	25 ± 5
404A51A4	J4	U	414A9L5 Eng. 2 Valve 1	26	25 ± 5
404A51A4	J4	V	414A9L2 Eng. 2 Valve C	26	25 ± 5
404A51A4	J4	W	414A9L6 Eng. 2 Valve 3	26	25 ± 5
404A51A4	J4	X	414A9L3 Eng. 2 Valve B	26	25 ± 5
404A51A4	J4	Y	414A9L7 Eng. 2 Valve 2	26	25 ± 5
404A51A4	J4	Z	414A9L4 Eng. 2 Valve D	26	25 ± 5
404A51A4	J4	a	414A9L8 Eng. 2 Valve 4	26	25 ± 5
404A7A19	J4	A	415A8L1 Eng. 1 Valve A	28	25 ± 5
404A7A19	J4	B	415A8L5 Eng. 1 Valve 1	28	25 ± 5
404A7A19	J4	C	415A8L2 Eng. 1 Valve C	28	25 ± 5
404A7A19	J4	D	415A8L6 Eng. 1 Valve 3	28	25 ± 5
404A7A19	J4	E	415A8L3 Eng. 1 Valve B	28	25 ± 5
404A7A19	J4	F	415A8L7 Eng. 1 Valve 2	28	25 ± 5
404A7A19	J4	G	415A8L4 Eng. 1 Valve D	28	25 ± 5
404A7A19	J4	H	415A8L8 Eng. 1 Valve 4	28	25 ± 5
404A7A19	J4	J	415A10L1 Eng. 3 Valve A	28	25 ± 5
404A7A19	J4	K	415A10L5 Eng. 3 Valve 1	28	25 ± 5
404A7A19	J4	L	415A10L2 Eng. 3 Valve C	28	25 ± 5
404A7A19	J4	M	415A10L6 Eng. 3 Valve 3	28	25 ± 5
404A7A19	J4	N	415A10L3 Eng. 3 Valve B	28	25 ± 5
404A7A19	J4	P	415A10L7 Eng. 3 Valve 2	28	25 ± 5
404A7A19	J4	R	415A10L4 Eng. 3 Valve D	28	25 ± 5
404A7A19	J4	S	415A10L8 Eng. 3 Valve 4	28	25 ± 5
404A7A19	J4	T	415A9L1 Eng. 2 Valve A	28	25 ± 5
404A7A19	J4	U	415A9L5 Eng. 2 Valve 1	28	25 ± 5
404A7A19	J4	V	415A9L2 Eng. 2 Valve C	28	25 ± 5
404A7A19	J4	W	415A9L6 Eng. 2 Valve 3	28	25 ± 5
404A7A19	J4	X	415A9L3 Eng. 2 Valve B	28	25 ± 5
404A7A19	J4	Y	415A9L7 Eng. 2 Valve 2	28	25 ± 5
404A7A19	J4	Z	415A9L4 Eng. 2 Valve D	28	25 ± 5
404A7A19	J4	a	415A9L8 Eng. 2 Valve 4	28	25 ± 5
404A4	J7	r	414A5L1	580	550-650
404A4	J7	d	414A5L1	550	550-650
404A4	J7	p	414A6L1	590	550-650
404A4	J7	x	414A1L1	590	550-650
404A4	J7	f	414A1L1	580	550-650
404A4	J7	v	414A2L1	580	550-650
404A4	J7	m	414A2L2	580	550-650
404A4	J7	t	414A2L2	560	550-650

4.1.4.1 (Continued)

Test Point			Component Nomenclature	Meas. Ohms	Limit Ohms
404A4	J7	z	Spare	Inf	10 meg min
404A4	J7	q	415A5L1	580	550-650
404A4	J7	c	415A5L1	560	550-650
404A4	J7	n	415A6L1	550	550-650
404A4	J7	w	415A1L1	580	550-650
404A4	J7	e	415A1L1	570	550-650
404A4	J7	u	415A2L1	570	550-650
404A4	J7	k	415A6L2	580	550-650
404A4	J7	s	415A2L2	580	550-650
404A4	J7	y	Spare	Inf	10 meg min
404A2A16	J2	B	414A7L1 Eng. 4 Valve A	600	550-650
404A2A16	J2	C	414A7L2 Eng. 4 Valve 1	610	550-650
404A2A16	J2	A	415A7L1 Eng. 4 Valve A	630	550-650
404A2A16	J2	D	415A7L2 Eng. 4 Valve 1	590	550-650

4.1.5 Stage Power Setup (1B55813 D)

Prior to initiating automatic test procedures, the stage power setup procedure verified the capability of the GSE automatic checkout system (ACS) to control power switching to and within the stage, and ensured that the stage forward and aft power distribution system was not subjected to excessive static loads during initial setup sequences. After the procedure was successfully demonstrated, it was used to establish initial conditions during subsequent automatic procedures throughout STC prefire testing.

This procedure was initially conducted on 7 September 1967. The first run was unsuccessful due to two missing stage wires, which were replaced per FARR A255448. The second run was conducted successfully and accepted on 11 September 1967. The following narration and the measurement values shown in Test Data Table 4.1.5.1 are from this last run.

The test started by resetting all of the matrix magnetic latching relays, and verifying that the corresponding command relays were in the proper state. Verification was made that the umbilical connectors were mated, and that the LOX and LH_2 inverters were disconnected. The bus 4D119 talkback power was turned on, and the prelaunch checkout group power was turned off. The forward power and the aft power buses were transferred to external power. The sequencer power, engine control bus power, engine ignition bus power, APS bus 1 and bus 2 power, and propellant level sensor power, were all verified to be off. The power to the range safety system 1 and 2 receivers and the EBW firing units was transferred to external and verified to be off. The switch selector checkout indication enable and the flight measurement indication enable were turned on.

4.1.5 (Continued)

The bus 4D131 28 vdc power was turned on, and the forward bus 1 initial current and voltage were measured. The range safety safe and arm device was verified to be in the safe condition.

The 70 pound ullage engine relay, the LH_2 and LOX repressurization mode relay, the LH_2 and LOX repressurization control valve relay, and the O_2H_2 burner propellant valve relay were reset. The LH_2 continuous vent and relief overboard valve was verified to be closed.

The propellant utilization boiloff bias was turned off. The O_2H_2 burner spark systems 1 and 2 voltages were measured and recorded. It was verified that the O_2H_2 burner LOX valve, LOX shutdown valve, LH_2 valve, and the LH_2 continuous vent orificed bypass valve were closed.

The forward bus 1 quiescent current was measured. The PCM system group was turned on and the amperage of the PCM system group was measured. The cold helium supply shutoff valve was closed. The aft 1 power supply current and voltage were measured and it was verified that the aft 1 local sensor was off. Sequencer power was turned on, the forward bus 2 current and voltage were measured, and it was verified that the forward 2 local sensor was off.

The prelaunch checkout group power was turned on and the current was measured. The forward and aft battery load test off commands were set, then the DDAS ground station selector switch was manually set to position 1, and it was verified that the ground station was in sync. The EBW pulse sensor power was turned off.

A series of checks verified that stage functions were in the proper state. Forty functions were verified to be off, and twenty functions were verified

4.1.5 (Continued)

to be on. The LOX and LH_2 prevalves and chilldown shutoff valves were verified to be open, and the LOX and LH_2 vent valves and fill and drain valves were verified to be closed.

The final operations measured the forward and aft 5 volt excitation module voltages, the range safety firing unit charging voltages, the aft bus 2 voltage, the forward and aft battery simulator voltages, and the component test power voltage.

There was one FARR, A255448, written during the operation of this procedure because two wires were missing in two stage cables, P/N 1B66967-1, (404A4W1) and P/N 1B66967-1, (404W7).

There were four revisions written to this procedure for the following:

a. One revision corrected the program to allow for a small current variation in the forward bus 2 current.

b. One revision explained that a malfunction printout was caused by wires missing from two cable harnesses, reference FARR A255448.

c. One revision accepted a malfunction printout which was caused by an operating error.

d. One revision authorized a rerun of the procedure to establish system and stage integrity after replacement of the missing wires.

4.1.5.1 Test Data Table, Stage Power Setup

Function	Measured Value	Limits
Forward Bus 1 Power Supply Current (amps)	6.80	20 max
Bus 4D31 Forward 1 Voltage (vdc)	28.44	28 + 2
O_2H_2 Burner Spark System 1 Voltage (vdc)	-0.03	0 ∓ 0.5
O_2H_2 Burner Spark System 2 Voltage (vdc)	-0.03	0 ∓ 0.5

4.1.5.1 (Continued)

Function	Measured Value	Limits
Forward Bus 1 Quiescent Current (amps)	1.90	5 max
PCM System Group Current (amps)	4.60	5 ± 3
Aft 1 Power Supply Current (amps)	0.40	2 max
Bus 4D11 Aft 1 Voltage (vdc)	28.28	28 ± 2
Sequencer Power (amps)	0.00	3 max
Forward Bus 2 Power Supply Current (amps)	0.70	2 max
Bus 4D21 Forward 2 Voltage (vdc)	28.04	28 ± 2
Prelaunch Checkout Group Current (amps)	1.80	4 ± 4
Aft 5v Excitation Module Voltage (vdc)	5.00	5.00 ± 0.030
Fwd 1 5v Excitation Module Voltage (vdc)	5.01	5.00 ± 0.030
Fwd 2 5v Excitation Module Voltage (vdc)	5.00	5.00 ± 0.030
Range Safety 1 EBW Firing Unit Chg Voltage (vdc)	0.00	0 ± 1
Range Safety 2 EBW Firing Unit Chg Voltage (vdc)	0.00	0 ± 1
Bus 4D41 Aft Bus 2 Voltage (vdc)	0.00	0 ± 1
Bus 4D30 Fwd Battery 1 Voltage (vdc)	-0.08	0 ± 1
Bus 4D20 Fwd Battery 2 Voltage (vdc)	-0.04	0 ± 1
Bus 4D10 Aft Battery 1 Voltage (vdc)	0.00	0 ± 1
Bus 4D40 Aft Battery 2 Voltage (vdc)	-0.16	0 ± 1
Component Test Power Voltage (vdc)	0.60	0 ± 1

4.1.6 Stage and GSE Manual Controls Check (1B70177 F)

This procedure defined the checkout required to certify manual mode control of the components in the propulsion GSE and stage systems. Pneumatic regulators and valves in consoles "A" and "B", and the LH_2 and LOX control skids and the pneumatic regulators on the stage were manually functioned. Manual control verification consisted of supplying electrical and pneumatic signals to system components and checking for the proper response.

The checkout was initiated on 7 September 1967, and verified as complete on 12 September 1967. The first section of the test certified that all GSE valves were functioning properly. Verification of proper operation was made by talk-back indication and audible means.

A check of the stage mounted components was accomplished next. All stage purge hand valves were closed and it was verified that the LH_2 and LOX pressure spheres were isolated in accordance with a procedural revision. From the stage supply panel, the control helium shutoff valve was closed and the control helium bottle fill valve was opened, until the control helium sphere pressure reached 100 ± 25 psig; then, the helium sphere valve was closed. The control helium bottle dump valve was opened, until the sphere pressure decayed to ambient; then, the control helium bottle dump valve was closed.

On the mainstage panel, the LOX and LH_2 chilldown valves and the LOX and LH_2 prevalves were cycled. At the LH_2 control panel, the tank fill and drain valve and the tank vent valve were cycled. The LH_2 tank vent boost and the fill and drain boost were cycled, and the directional vent was placed in the flight position; then, returned to the ground position.

4.1.6 (Continued)

At the LOX control panel, the tank vent valve, the cold helium shutoff valve, and the LOX fill and drain valve were cycled. The tank vent boost and fill and drain valve boost were cycled.

The engine control bottle dump, the cold helium dump, the start tank dump, the LOX repressurization dump, the LH_2 repressurization dump and the control helium bottle fill on the stage supply panel were cycled.

An LH_2 and LOX umbilical purge interlock check was accomplished next. At the LH_2 control panel, the LH_2 fill and drain valve and the LH_2 umbilical drain valve were verified to be closed. The LH_2 umbilical purge valve was then opened and talkback indication was verified. The LH_2 fill and drain valve was cycled and it was verified that the LH_2 umbilical purge valve opened and closed. Verification was made that operating the LH_2 umbilical drain valve also operated the LH_2 umbilical purge valve.

On the LOX control panel, the LOX emergency drain valve was opened, and the LOX fill and drain and the LOX umbilical drain valves were closed. The LOX umbilical purge valve was positioned to open and talkback indication was verified. The LOX fill and drain and the LOX umbilical drain valves were cycled to verify that the LOX umbilical purge valve opened and closed as the drain valves were functioned.

The helium supply hand valve in console "A" was closed. The stage 1 bleed valve was opened, and the stage 1 line pressure was verified to be ambient. All systems were verified to be at ambient.

4.1.6 (Continued)

There were no failure and rejection reports written and all parts were installed at the start of the test. Three revisions were made to the procedure for the following:

a. One revision performed the isolation of the LH_2 repressurization sphere, because the test preparation document, 1B70422, was not active.

b. Two revisions updated the procedure to the latest configuration.

4.1.7 Cryogenic Temperature Sensor Verification (1B44471 C)

The calibration and functional capabilities of the cryogenic temperature sensors, for which the normal operating range did not include ambient temperature, were verified by this manual procedure. The sensors, basically platinum resistance elements, indicated changes in temperature as their resistance varied with changes in temperature, in accordance with the Callendar-Van Dusen equation.

Accomplished on 7 September 1967, the testing and the results obtained were accepted by Engineering on the same date.

Each sensor was tested at the prevalent ambient temperature. Using the values for resistance at 32°F and sensitivity, which were given for each individual sensor, the expected resistance at room temperature was calculated. The actual resistance was measured, and compared with the calculated value. The measured resistance was required to be within 5 per cent of calculated resistance, except for eleven specified sensors which were allowed a 7 per cent tolerance. The sensor wiring was verified to be correct by shorting out the sensor element, measuring the continuity resistance, and by verifying that this was 5.0 ohms or less. Test Data Table 4.1.7.1, shows the measured and calculated values for each sensor involved in this test.

Engineering comments indicated that there were no parts shortages affecting this test. No problems were encountered during the test, no FARR's were written, and the checkout was accepted by Engineering. Three revisions were made to the procedure for the following:

4.1.7 (Continued)

a. One revision changed adapter cable, P/N 1B40895-1, to P/N 1B64095-1, as the 1B40895-1 cable does not have a wire to Pin "B" as required.

b. One revision changed the reference location number for measurement 00134-401 from 404A64A200 to 404A64A220. The original callout was in error.

c. One revision accepted an apparent out-of-tolerance reading as the transducer is of such a low value of resistance that the resistance of the wire is greater than that of the transducer.

4.1.7.1 Test Data Table, Cryogenic Temperature Sensor Verification

Meas. Number	P/N	Sensor S/N	Ref. Desig.	Temp. (°F)	Resistance (ohms) Meas.	Calc.	± Tol.
00 003	1B34473-1	334	403MT686	73	5200	5451	382
00 004	1B34473-501	323	403MT687	73	1548	1526	76
00 005	1A67863-503	868	405MT612	73	547	545	27
00 009	1A67863-535	1146	403MT653	78	222	220	78
00 015	1A67863-509	1051	410MT603	80	1550	1548	77
00 040	1A67862-505	564	406MT613	73	1507	1504	27
00 052	1A67862-513	316	408MT612	80	5500	5528	387
00 057	1A67862-501	551	406MT606	73	547	545	27
00 059	1A67862-517	51424	406MT611	73	543	545	27
00 133	NA5-27215T5	13531	401(3MTT17)	73	1388	1369	68
00 134	NA5-27215T5	13535	401(3MTT16)	73	1380	1369	68
00 159	1A67863-519	785	424MT610	78	222	220	11
00 161	1A67862-537	1172	404MT733	78	5290	5506	385
00 208	1A67862-503	856	405MT605	73	546	545	27
00 230	1A67862-509	1088	403MT706	73	1533	1526	76
00 231	1A67862-529	1064	403MT707	73	548	545	27
00 256	1B37878-501	1431	409MT646	80	1577	1548	77
00 257	1B37878-501	1418	409MT647	80	1550	1548	77
00 368	1A67862-505	561	406MT660	73	1495	1504	75
00 369	1A67862-505	566	406MT661	73	1490	1504	75
00 370	1B51648-507	59802	408MT735	80	5330	5528	276
00 371	1B51648-507	64395	408MT736	80	5260	5528	276
00 384	1B37878-511	1471	403MT779	73	546	545	27
00 391	1A68589-519	H94	403MT784	73	12.2 †	11.025	0.55

† See revision C.

4.1.8 Common Bulkhead Vacuum System (1B49286 H)

The purpose of this manual checkout, initiated on 9 September 1967, was to ensure that the common bulkhead, P/N 1A39309-501, was free of leakage conditions and acceptable for propellant loading and static acceptance firing of the J-2 engine.

The test stand vacuum system was isolated from the stage system, and the test stand system setup for checkout. The vacuum pump was operated for 10 minutes; then shutoff. After a 15 minute delay, the vacuum system pressure was recorded. At intervals of 1 hour, the pressure was monitored for a pressure rise. No increase in pressure was noted over an 8-hour span.

The test stand system was reconnected to the stage and preparations for a 96-hour pumpdown of the common bulkhead were made. The evacuation supply was set to evacuate the bulkhead, the vacuum supply and vacuum pump were turned off, and the purge supply and sample supply were verified to be closed. Verification was made that measurement D545, the bulkhead transducer, P/N 1B40242-501, was installed and electrically connected to the monitoring strip charts in the Test Control Center.

It was verified that the common bulkhead quick-disconnect assembly, P/N 1B410-65, was properly installed and engaged. Two sample bottles, P/N 1B71532-1, were installed at positions 1 and 2 on the sample bottle rack and sealed into place. The vacuum supply switch was turned on. After 10 minutes, the evacuation supply switch was set to evacuate the bottles, and sample supply switch number 1 was opened. After 5 minutes, sample supply switch number 1 was

4.1.8 (Continued)

closed, the evacuation supply switch was set to sample the bulkhead, and sample supply switch number 1 was re-opened. After 1 minute, sample supply switch number 1 was closed, and the evacuation supply switch was set to evacuate the bulkhead. Bulkhead pressure was monitored every hour for 6 hours, with no pressure rise noted. Upon completion of the 6-hour check, the evacuation supply switch was set to evacuate the bottles, and sample supply switch number 2 was opened. After a lapse of 5 minutes, sample supply switch number 2 was closed, the evacuation supply switch was set to sample the bulkhead, and sample supply switch number 2 was opened for 1 minute, then closed. The sample bottles, number 1 and 2, were removed from the sample bottle rack and shipped to Materials and Methods - Research and Engineering (MM-RE) for analysis.

After 96 hours of vacuum pumpdown, the vacuum supply switch was turned off, and the evacuation supply switch was set to evacuate the bottles. Then the 48-hour bulkhead decay check was started. The indicated bulkhead pressure at the start was recorded as 1.0 psia. No decay in bulkhead pressure was noted. During the decay check, a setup was made for the argon purge test. A bottle of 99 percent pure argon was connected to the bulkhead GN_2 supply line. The bulkhead GN_2 purge hand valve was opened, the evacuation supply switch was set to evacuate the bulkhead, and the purge supply regulator was set to 2.5 psig. The argon purge was run for 24 hours. After 24 hours, the argon purge was completed, the argon bottle was removed, and the bulkhead vacuum system was secured.

4.1.8 (Continued)

The bulkhead leak check was accomplished next. Bulkhead pressure was determined to be 14.7 psia. The LOX tank was pressurized to 30 $\pm$ 1 psia and the LH_2 tank was pressurized to 25 $\pm$ 1 psia. This pressure was maintained for 12 hours while the bulkhead pressure was monitored. No increase in bulkhead pressure was noted, indicating that the bulkhead was free from leakage. The propellant tanks were vented to ambient and this checkout was certified as acceptable on 3 October 1967.

Engineering comments revealed no part shortages and no interim use material items installed at the start of this test. There were no failure and rejection reports written as a result of this checkout.

There were nine revisions written to the procedure:

a. Three revisions added steps to the procedure to update the test.

b. One revision corrected a procedural error.

c. Four revisions reran sections to troubleshoot a suspected leak.

d. One revision secured the bulkhead pumpdown over a weekend to eliminate the necessity for a monitor.

4.1.9 Preliminary Propulsion Leak and Functional Check (1B71877 A)

This checkout procedure defined the operations required to perform the leak and functional checks which certified the stage propulsion system preparatory to static firing. All portions pertaining to S-IB stages and postfire operations were deleted. The prefire test sequences performed during this checkout were initiated on 9 September 1967, and were completed on 28 September 1967. The major components tested in accordance with this procedure appear in the last portion of Test Data Table 4.1.9.1.

The O_2H_2 burner spark ignitor arcing check consisted of a visual observation of the spark gap for constant arcing across the plate while the exciter power was on. The observation was accomplished by sighting through the 9/16 inch diameter hole in the guage assembly, P/N 1B67184-1, which was installed into the O_2H_2 burner adapter flange. This checkout was repeated on the second spark ignitor. Inspection Item Sheet (IIS) 202970 reported that the helium heater ignitor number 1 and 2 electrodes, P/N 1B59986-503, were both protruding from the porcelain insulators and were bent. After replacement of the ignitor electrodes per FARR A261610, this test section was satisfactorily completed.

The cold helium fill module relief and internal seat leakage test was accomplished next by removal of the module from the stage for shipment to LOX service for leakage and relief tests. The checks were satisfactorily completed.

The reverse leak check of the check valves of the actuation control modules for the LH_2 and LOX systems was performed to ensure that the check valves

4.1.9 (Continued)

functioned within the tolerance limits. The calip pressure switch system leak checks performed a decay check of the LOX and LH_2 pressure switch checkout circuits by pressurizing the system to 30 ± 5 psia, and monitoring it for 5 minutes. A decay and leak check of the mainstage pressure switches was accomplished by pressurizing the system to 400 ± 10 psig, through the J-2 customer connect panel, isolating the mainstage switches from the supply source, and monitoring decay for 15 minutes. All decay checks were satisfactorily completed.

Stage integrity checks performed pickup and dropout pressure tests on the control helium regulator discharge pressure switch and the cold helium regulator backup pressure switch. Audible leak checks were conducted on the cold and ambient helium systems, the engine spheres, and the stage tanks by pressurizing the engine control bottle to 350 ± 50 psig, the start tank to 250 ± 50 psig, the LOX tank to 5 psig, and the LH_2 tank to 3 psig. At the completion of the above audible leak checks, stage integrity checks were continued by pressurizing the control helium bottle to 3100 ± 100 psig, the start tank to 800 ± 25 psig, the cold helium spheres to 2275 ± 50 psig, and the engine control bottle to 2250 ± 50 psig. The aforementioned pressures were held for 5 minutes. The LOX and LH_2 tanks were pressurized to the relief pressure, while the vent valves were allowed to perform three relief cycles. The stage integrity checks were satisfactorily completed.

The ambient helium system leak and flow check was accomplished next. This section began with an orifice flow verification of the purge system, a reverse leak check of the valves, and a leak check of the purge system. An internal

4.1.9 (Continued)

leak check of the ambient helium fill module and the pneumatic power control module was performed next. Then, the ambient LOX and LH_2 repressurization system was functioned and checked for internal leakage. The ambient LH_2 repressurization module backup check valve was checked for reverse leakage; then, the ambient repressurization system was leak checked. The control helium system was functioned, and checked for leakage. The pneumatic control system was locked up and checked for pressure decay over a 30 minute period. Eleven conditions of leakage were noted during this checkout. All leaks, except one, were corrected by retorqueing and replacing the unions and seals. The leakage at the stem of the LH_2 vent purge valve was documented on FARR A261635. The valve was subsequently accepted for use without reworking it.

The engine start system leak and functional checks included a drying sequence for the start tank vent valve actuator, a seat leak check of the start tank control solenoid valve, and a reverse leak check of the start tank fill check valve. Leak checks were performed on the GH_2 start system, the start tank dump-control solenoid seal, and the vent and relief valves and valve bellows. Start bottle retention tests were conducted to measure the start bottle decay by calculating the pound-mass/hour-loss. All tests of the engine start system were satisfactorily completed.

The LH_2 pressurization and repressurization system leak and functional checkouts included a functional check of the O_2H_2 burner LH_2 repressurization control valves, a reverse leak test of the O_2H_2 burner LH_2 check valve, and leak checks of the repressurization system and the O_2H_2 burner LH_2 repressurization

4.1.9 (Continued)

control valve seat and pilot bleed valve. This section also performed a reverse leak test of the fuel pressure module check valve, and the LH_2 prepressurization check valve. All tests were satisfactorily completed.

Thrust chamber leak checks included a leak check of the thrust chamber system, reverse leakage of the engine LOX dome purge check valve, and flow checks of the main fuel and oxidizer valve drive and idler shaft seals. This section also covered reverse leakage of the thrust chamber jacket purge check valves. One condition of leakage noted during this section was subsequently corrected by replacement of a seal. All tests were satisfactorily completed.

The LOX pressurization and repressurization system leak and functional checks performed a reverse leak check of the cold helium sphere fill check valve, an internal leak and functional check of the LOX pressurization module, a LOX pressurization system leak check, a leak and functional check of the O_2H_2 burner LOX repressurization system, a LOX repressurization system leak check, and a cold helium system leak check. One condition of leakage noted during these checks was corrected by replacing a union.

Leak checks were then performed on the LOX tank, the O_2H_2 burner, and the engine LOX feed system. Internal leak checks of the engine feed system checked for seat leakage of the LOX prevalve and chilldown shutoff valve, the engine LOX bleed valve, the engine main oxidizer valve, and checked for reverse leakage of the LOX chilldown return check valve. Then the LOX tank and the engine feed system were leak checked. The LOX turbopump was checked for breakaway

4.1.9 (Continued)

torque and running torque, and was checked for primary seal leakage. The LOX chilldown pump purge flow checks included checks of the LOX chilldown pump purge flow and chilldown pump purge bypass flow, seat leakage checks of the chilldown pump purge module shutoff valve and the chilldown pump purge dump valve, seal leakage checks of the chilldown pump shaft (in the pump direction and in the tank direction), and a general leak check of the chilldown pump purge system.

Then the LOX prevalve shaft seal was leak checked with the prevalve opened and closed. The LOX fill and drain valve was checked for seat leakage. Next, leak checks of the LOX umbilical and the main fill and replenish valve seat were performed. Seat leakage checks of the O_2H_2 burner LOX propellant valve and the O_2H_2 burner LOX shutdown valve, and a leak check from the LOX tank to the O_2H_2 burner LOX propellant valve were performed. Four conditions of leakage noted during these tests were corrected by replacement of seals.

Leak checks were then performed on the LH_2 tank, the O_2H_2 burner, and the engine LH_2 feed system. Internal leak checks of the engine feed system checked for seat leakage of the LH_2 prevalve and chilldown shutoff valve, the engine LH_2 bleed valve, the engine main fuel valve, and checked for reverse leakage of the LH_2 chilldown return valve. The LH_2 engine pump drain check valve, the LH_2 turbine seal cavity purge check valve, and the LOX turbine seal cavity check valve were checked for reverse leakage. The LH_2 engine pump intermediate seal was checked for leakage. The LH_2 engine pump drain check valve was also checked for forward flow. Then the LH_2 tank and the engine feed system were

4.1.9 (Continued)

leak checked. Next, the LH_2 turbopump was checked for breakaway and running torque, and was checked for primary seal leakage.

The LH_2 prevalve shaft seal was leak checked with the valve opened and closed. The LH_2 fill and drain valve was checked for seat leakage. Leak checks of the LH_2 umbilical and the main fill and replenish valve seat were performed. Then leak checks of the O_2H_2 burner LH_2 propellant valve seat and the LOX shutdown valve seat were made, as well as a general leak check of the O_2H_2 propellant system. One condition of leakage noted during these checks was corrected by the replacement of a seal.

Leak and flow checks of the engine gas generator (GG) and exhaust system were conducted next, and included reverse leak checks of the GG LH_2 purge check valve, the GG LOX purge check valve, and the GG LOX poppet. Leak checks of the start tank discharge valve gate seal and the hydraulic pump seal were conducted. A bleed flow check of the LH_2 and LOX turbine seal cavity was conducted. General leak checks of the GG and exhaust system and the pressure actuated purge system were also conducted. One condition of leakage noted was corrected by the replacement of a seal.

Engine pump purge leak and flow checks performed a regulation check of the engine pump purge module discharge pressure, measured the seat leakage of the engine pump purge valve, checked the purge flows of the LOX and LH_2 turbine seal cavity bleed exits and the LH_2 pump drain test port, and verified the GG fuel purge flow of the LH_2 turbo pump access. All engine pump purge leak checks were satisfactorily completed.

4.1.9 (Continued)

Leak and flow checks of the engine pneumatics included the helium control solenoid energized leak checks, the LOX intermediate seal purge flow checks, the ignition phase solenoid energized leak checks, the start tank discharged valve solenoid energized leak checks, the mainstage control solenoid energized leak checks, the pressure actuated purge system leak checks, and the engine control bottle fill system leak checks. Also the engine control bottle retention tests were conducted to determine the control bottle decay by calculating the pound-mass/hour-loss.

LOX and LH_2 vent system leak and flow checks included leak checks of the nonpropulsive vent ducting; the nonpropulsive vent and ground system vent; the LOX and LH_2 vent systems; the LOX vent and relief, and the relief valve internal leakage; the LH_2 vent and relief, relief, and the directional vent valve internal leakage; and an actuator piston leak check of the LH_2 directional vent. All tests of the LOX and LH_2 vent system were satisfactorily completed. Three leaks were corrected by the replacement of seals and retightening to the proper torque value.

Of the twenty conditions of leakage described in the leak check log, eighteen were stage oriented, and two were facility oriented. The stage oriented conditions of leakage were corrected by retightening to the proper torque value, replacement of seals, and/or components with subsequent retightening to the proper torque value. The facility oriented conditions of leakage were accepted by Engineering, although the leakage conditions remained after retightening.

4.1.9 (Continued)

As a result of this checkout, two FARR's were generated for the following:

a. FARR A261610 noted that the helium heater ignitor electrodes 1 and 2, P/N 1B59986-503, were protruding from the porcelain insulators and were bent. The ignitor electrodes were replaced.

b. FARR A261635 noted that there was excessive leakage at the stem of the LH_2 vent purge valve. The valve was accepted for use because it was used for checkout purposes only.

There were fifty-four revisions written against this test procedure for the following:

a. Twenty-five revisions corrected and/or added requirements that were in error or missing.

b. Nine revisions added steps to acquire Engineering data and/or temporary hardware installations.

c. Six revisions repeated leak checks and/or requirements previously accomplished.

d. Five revisions were incorporated to leak check hardware which was replaced subsequent to its system leak checks.

e. Five revisions added steps to troubleshoot leakage conditions.

f. Three revisions deleted previous revisions or portions thereof.

g. One revision accepted an in-tolerance condition of leakage.

There were no missing or IUM parts. The propulsion systems leak and functional checks were acceptable to Engineering.

4.1.9.1 Test Data Table, Propulsion Leak and Functional Check

Cold Helium Fill Module Relief & Internal Leakage Checks

Function	Measurement			Limits
	Cycle 1	Cycle 2	Cycle 3	
Relief Valve				
Crack Pressure (psig)	3200	3200	3200	*
Reseat Pressure (psig)	3150	3150	3150	*
Internal Leak Check at 3100 $\pm$100 psig				
Relief Valve Seat Leakage (scim)		0		5 max
Dump Solenoid Seat Leakage (scim) (Pilot Bleed & Seat - Combined)		0		5 max
Internal Leak Check at 500 $\pm$50 psig				
Relief Valve Seat Leakage (scim)		0		12.5 max
Dump Solenoid Seat Leakage (scim) (Pilot Bleed & Seat - Combined)		0		12.5 max

Actuation Control Module Check Valve Reverse Leak Checks (P/N 1B67481-1)

Function	S/N	Measurement	Limits
LH_2 & LOX Chilldown Shutoff Valve (L1) Check Valve (scch)	70621209	0	1 max
LH_2 & LOX Prevalve (L2) Check Valve (scch)	7062189	0	1 max
LH_2 Fill & Drain Valve (L1) Check Valve (scch)	70621208	0	1 max
LH_2 Fill & Drain Valve (L2) Check Valve (scch)	70621116	0	1 max
LOX Fill & Drain Valve (L1) Check Valve (scch)	7062153	0	1 max
LOX Fill & Drain Valve (L2) Check Valve (scch)	7062174	0	1 max
LOX Vent Valve (L1) Check Valve (scch)	70621214	0	1 max
LOX Vent Valve (L2) Check Valve (scch)	70621147	0	1 max
LH_2 Vent Valve (L1) Check Valve (scch)	7062173	0	1 max
LH_2 Vent Valve (L2) Check Valve (scch)	7062165	0	1 max
LH_2 Bidirectional Vent (L1) Check Valve (scch)	7062191	0	1 max
LH_2 Bidirectional Vent (L2) Check Valve (scch)	70621173	0	1 max
LH_2 Continuous Vent (L1) Check Valve (scch)	70621101	0	1 max
LH_2 Continuous Vent (L2) Check Valve (scch)	7062156	0	1 max

* Limits Not Specified

4.1.9.1 (Continued)

Function	S/N	Measurement	Limits
LH_2 Propellant Valve (L1) Check Valve (scch)	70621143	0	1 max
LH_2 Propellant Valve (L2) Check Valve (scch)	70621196	0	1 max
LOX Propellant Valve (L1) Check Valve (scch)	7062160	0	1 max
LOX Propellant Valve (L2) Check Valve (scch)	70621102	0	1 max

Calip Pressure Switch Leak Checks

Function	Measurement	Limits
LOX Press Sw C/O Circuit Decay (psi)	0.0	5.0 max/5 minutes
LH_2 Press Sw C/O Circuit Decay (psi)	0.1	5.0 max/5 minutes
Low Press Sw C/O Circuit Decay (psi)	4.5	5.0 max/5 minutes
Eng Mnstg Press Sw Diaph Decay:		
Initial (psig)	400	
Final (psig)	399	
Decay (psi)	1.0	10.0 max/15 minutes

Stage Integrity Checks

Function	Measurement Run 1	Run 2	Run 3	Limits
Control He Reg Disch P/S:				
Pickup Press (psia)	608.7	606.7	606.7	600 ± 21
Dropout Press (psia)	488.7	486.7	486.7	490 ± 31
Cold He Reg Backup P/S:				
Pickup Press (psia)	464.7	466.7	466.7	444 to 491
Dropout Press (psia)	345.7	345.7	345.7	329 to 376
LOX Tank Relief Cycle (psia)	41.8	41.9	41.9	41 to 44
LH_2 Tank Relief Cycle (psia)	35.5	35.5	35.5	34 to 37

Ambient Helium System Flow Checks

Function	Measurement	Limits
LOX Tnk Ullage Sense Line Purge (scim)	300	432 ± 245
LOX F&D Vlv Microsw Housing Purge (scim)	2.3	3.5 ± 2
LH_2 F&D Vlv Microsw Housing Purge (scim)	1.5	3.5 ± 2
LH_2 C/D Shutoff Vlv Microsw Purge (scim)	5600	6500 ± 2450
LH_2 Prop Vlv Microsw Purge (scim)	72	70 ± 30
Nonpropulsive Vent Duct Purge (scim)	2.4	3.5 ± 2
Contin Vent Mod Purge (scim)	2.5	3.5 ± 2
Orifice Bypass Vlv Microsw Purge (scim)	320	432 ± 245
Contin Vent Duct Purge (scim)	290	432 ± 245

4.1.9.1 (Contined)

Purge System Check Valve Reverse Leak Checks (P/N 1B51361-1)

Check Valve Function	S/N	Measurement	Limits
LOX Vent Purge (scim)	355	1	10 max
LOX Fill & Drain Purge (scim)	294	0	10 max
LH_2 Fill & Drain Purge (scim)	194	0	10 max
LH_2 Vent Purge (scim)	285	0	10 max

Ambient He Fill Module Internal Leak Checks (P/N 1A57350-507-002, S/N 0232)

Function	Measurement	Limits
Check Valve Reverse Leakage (scim)	0	0
Dump Valve Seal Leakage (scim)	0	0

Ambient He Spheres Fill System Check Valves Reverse Leak Checks (P/N 1B51361-1)

Function	S/N	Measurement	Limits
LOX Repress Mod Check Vlv (scim)	-	0	10 max
LH_2 Repress Mod Backup Check Valve (scim)	290	0	10 max
LH_2 Repress Mod Check Vlv (scim)	-	0	10 max
He Fill Mod Backup Check Valve (scim)	306	0	10 max

Ambient Repress Module Control Valve Functional Checks

LOX Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0	*
Cont Vlv (L2) Seat Leakage (scim)	0	*
Module Dump Vlv Seat Leakage (scim)	0	*
Mod Dump Vlv Pilot Bleed (scim)	0	*
Mod Dump Vlv Seat & Pilot Bleed Leakage (scim)	0	9 max
Cont Vlv (L2) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L2) Seat & Pilot Bleed Leakage (scim)	0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L3) Seat & Pilot Bleed Leakage (scim)	0	9 max

* Limits Not Specified

4.1.9.1 (Continued)

LH_2 Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seal Leakage (scim)	0	*
Cont Vlv (L2) Seat Leakage (scim)	0	*
Module Dump Vlv Seat Leakage (scim)	0	*
Module Dump Vlv Pilot Bleed Leakage (scim)	0	*
Mod Dump Vlv & Pilot Bleed Seat Lkg (scim)	0	9 max
Mod Cont Vlv (L2) Pilot Bleed Lkg (scim)	0	*
Cont Vlv (L2) Seat & Pilot Bleed Lkg (scim)	0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0	*
Cont Vlv (L3) Seat & Pilot Bleed Leakage (scim)	0	9 max

Pneumatic Power Control Module Internal Leak Check (P/N 1A58345-519, S/N 1039)

Function	Measurement	Limits
Control He Shutoff Seat Leakage (scim)	0	10 max
Control Module Reg Lockup Press (scim)	526	550 max

Actuation Control Module Checks (P/N 1B66692-501)

Module Function	S/N	Normal	Open	Closed	Limits
O_2H_2 Burner LOX Vlv Control (scim)	84	0	0	0	6 max
O_2H_2 Burner LH_2 Vlv Control (scim)	85	0	0	0	6 max
Orificed Bypass Vlv Control (scim)	32	0	0	0	6 max
		Normal	Open	Boost	
LOX Vent Valve Control (scim)	24	0	0	0	6 max
LH_2 Fill & Drain Vlv Control (scim)	27	0	0	0	6 max
LOX Fill & Drain Vlv Control (scim)	26	0	0	0	6 max
LH_2 Vent Valve Control (scim)	33	0	0	0	6 max
		Open		Closed	
LH_2 F&D Act Seal Lkg (scim)	24	0.0		0.0	2 max
LOX F&D Act Seal Lkg (scim)	26	0.0		0.0	2 max
LH_2 Cont Vent Act Piston & Shaft Seal Lkg (scim)		0.0		0.0	20 max
Cont Vent Bypass Shutoff Vlv Act Lkg (scim)	32	0.0		0.0	5 max
		Normal	Flight	Ground	
Directional Vent Valve Control	35	0	0	0	6 max

* Limits Not Specified

4.1.9.1 (Continued)

Module Function	S/N	Normal	Closed	Limits
Prevalve/Chilldown Valve Control (scim)	25	0	-	6 max
Prevalve Control (scim)	25	-	0	6 max
Chilldown Valve Control (scim)	25	-	0	6 max

Pneumatic Control System Decay Checks

Function	Measurement		Limits
	Initial	Final	
Reg Disch Press - Valve Pos, Normal (psig)	528.0	515.0	*
Reg Disch Press - Valve Pos, Activated (psig)	520.5	510.0	*

Engine Start Tank Leak Checks

Function	Measurement	Limits
Vent Control Solenoid Seat Leakage (scim)	0	10 max
Initial Fill, Check Valve Reverse Lkg (scim)	0	2 max
Vent & Relief Valve Seat Leakage (scim)	0	2 max
Dump Valve Bellows Leakage (scim)	0	0
Bottle Decay (Delta M) (lb-mass/hr)	0.0044	0.0066 max

LH_2 Repressurization System Leak Checks

Function	Measurement	Limits
O_2H_2 Burner Control Vlv Seat Leakage (scim)	0	*
O_2H_2 Burner Control Vlv Pilot Bleed Lkg (scim)	0	*
O_2H_2 Burner Module Cont Vlv Int Leakage (scim)	0	12 max
O_2H_2 Burner Cont Vlv & Check Vlv Rev Lkg (scim)	0	*
O_2H_2 Burner Check Vlv Reverse Leakage (scim)	0	5 max
O_2H_2 Burner Coil Leakage (scim)	0	0

LH_2 Pressurization System Leak Check

Function	Measurement	Limits
LH_2 Press Module Check Vlv Rev Lkg (scim)	0	10 max
LH_2 Prepress Check Vlv Rev Lkg (scim)	0	0

* Limits Not Specified

4.1.9.1 (Continued)

Thrust Chamber Checks

Function	Measurement	Limits
LOX Dome		
Purge Check Valve Reverse Lkg (scim)	2.5	4 max
Main Oxidizer Valve		
Idler Shaft Seal Leakage (scim)	0	10 max
Drive Shaft Seal Leakage (scim)	0	10 max
Main Fuel Valve		
Idler Shaft Seal Leakage (scim)	0	10 max
Drive Shaft Seal Leakage (scim)	0.9	10 max
Thrust Chamber		
Pressure (psig)	24	20 min
Jacket Purge Check Vlv Rev Lkg (scim)	0	25 max

LOX Pressurization & Repressurization System Leak Checks

Function	Measurement	Limits
Cold Helium Sphere		
Fill Check Vlv Rev Lkg (scim)	0	0
Shutoff Vlv Seat & Pilot Bleed Lkg (scim)	65	375 max
LOX Press Module Internal		
Hot Gas Bypass Vlv Seat & Pilot Bleed Lkg (scim)	0	1000 max
O2H2 Burner LOX Repress System		
Burner Control Valve Seal Leakage (scim)	0	*
Burner Control Valve Pilot Bleed Lkg (scim)	0	*
Burner Module Control Vlv Internal Lkg (scim)	6.5	12 max
System Check Valve Reverse Leakage (scim)	0	5 max
Combined Burner Check Vlv & Cont Vlv Seat Leakage (scim)	0	0
Burner Check Vlv Rev Leakage (scim)	0	0
Burner Coil Leakage (scim)	0	0
Cold Helium System		
LOX Tank Prepress Check Vlv Rev Leakage (scim)	0	0

LOX Tank, O2H2 Burner & Engine Feed System Leak Checks

Function	Measurement	Limits
LOX Tank Helium Content		
Top (%)	95.2	75 min
Bottom (%)	75.7	75 min
Engine Feed Sys Internal Leak Checks		
LOX Prevlv & Chilldown Shutoff Vlv Seat & Chilldown Return Check Vlv Lkg (scim)	4.2	*
LOX Chilldown Ret Check Vlv Rev Lkg (scim)	3.2	350 max

* Limits Not Specified

4.1.9.1 (Continued)

Function	Measurement	Limits
LOX Prevlv & Chilldown Shutoff Vlv Combined Seat Leakage (scim)	1.0	150 max
LOX Bleed Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	3.4	*
LOX Bleed Vlv Seat Leakage (scim)	-0.2	300 max
Main Oxidizer Vlv Seat Leakage (scim)	0.0	10 max
<u>LOX Tank & Engine Feed System Leak Checks</u>		
LOX Low Pressure Duct Pressure (psig)	44	45 max
Oxidizer Pump Speed Pickup Seat Bleed (scim)	0	0
<u>LOX Turbopump Torque Checks</u>		
Pump Primary Seal Leakage:		
Max (scim)	64	350 max
Min (scim)	52	350 max
Turbine Torque:		
Breakaway (in/lbs)	36	1000 max
Running (in/lbs)	33	200 max
<u>LOX Chilldown Pump Purge Flow Checks</u>		
Pump Purge Shutoff Sol Vlv Leakage (scim)	0	1 max
Pump Purge Bypass Flow (scim)	11.2	10 ± 2
Pump Purge Flow (scim)	40	33 to 49
Pump Purge Dump Sol Seat Leakage (scim)	0	0
Pump Shaft Seal Leakage (scim) (Tank Pressurized & Purge On)	0.8	50 max
Pump Shaft Seal Lkg - Pump Direction (scim)	0	75 max
Pump Shaft Seal Lkg - Tank Direction (scim)	0.8	25 max
<u>LOX Boiloff Valve Flow Check</u>		
Valve Seat Leakage (scim)	0	10 max
<u>LOX Turbopump Torque Checks</u>		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0	10 max
Closed Position (scim)	0	10 max
Internal Closed Pos (scim)	0	75 max
Fill and Drain Valve Seat Leakage (scim)	0	18 max
Fill and Drain Vlv Primary Shaft Seal Lkg (scim)	0	6.1 max
<u>LOX Umbilical & Main Fill & Replenish Vlv Seat Leak Checks</u>		
LOX Main Fill, Replenish, & Fill & Drain Vlvs Seat Leakage (scim)	0	*
LOX Main Fill & Replenish Vlvs Seat Lkg (scim)	0	*
<u>O_2H_2 Burner LOX System Leak Check</u>		
Burner LOX Prop Valve Seat Leakage (scim)	0	0.7 max
Burner LOX Shutdown Valve Seat Leakage (scim)	0	*

* Limits Not Specified

4.1.9.1 (Continued)

LH2 Tank, O2H2 Burner & Engine Feed System Leak Checks

Function	Measurement	Limits
LH_2 Tank Helium Content (%)	99.9	75 min
Engine Feed System Internal Leak Checks		
LH_2 Prevlv & Chilldown Shutoff Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	3.9	*
LH_2 Chilldown Ret Check Vlv Rev Lkg (scim)	0.7	350 max
LH_2 Prevlv & Chilldown Shutoff Vlv Combined Seal Leakage (scim)	3.2	150 max
LH_2 Bleed Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	0.8	*
LH_2 Bleed Vlv Seat Leakage (scim)	0.1	300 max
MOV & MFV Combined Seat Leakage (scim)	0	*
Main Fuel Vlv Seat Leakage (scim)	0	10 max
Engine Purge System Leak Checks		
LH_2 Pump Drain Check Vlv Rev Leakage (scim)	0.3	25 max
LH_2 Pump Drain Check Vlv Fwd Flow 30 psi (scim)	0.2	30 max
LH_2 Pump Drain Check Vlv Fwd Flow 60 psi (scim)	6000	2420 min
LH_2 Pump Purge Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Pump Intermediate Seal Leakage (scim)	9	500 max
LH_2 Turbine Seal Cavity Prg Check Vlv Rev Leakage (scim)	0	25 max
LOX Turbine Seal Cavity Prg Check Vlv Rev Leakage (scim)	0	25 max
LH_2 Tank & Engine Feed System Leak Checks		
LH_2 Low Pressure Duct Pressure (psig)	28	30 max
LH_2 Pump Speed Monitor Seal Bleed (scim)	0	0
LH_2 Turbopump Torque Checks		
LH_2 Pump Primary Seal Leakage:		
Max (scim)	7.2	350 max
Min (scim)	5.7	350 max
Turbine Torque:		
Breakaway (in/lbs)	26	1000 max
Running (in/lbs)	25	300 max
LH_2 Valves Leak Checks		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0	10 max
Closed Position (scim)	0	10 max
Fill & Drain Valve Seat Leakage (scim)	0	18 max
LH_2 Fill & Drain Vlv Primary Shaft Seal Leakage (scim)	0	6.1 max

* Limits Not Specified

4.1.9.1 (Continued)

Function	Measurement	Limits
LH$_2$ Umbilical & Main Fill & Replenish Valve Seat Leak Checks		
LH$_2$ Main Fill, Replenish, & Fill & Drain Valves Seat Leakage (scim)	0	*
LH$_2$ Main Fill & Replenish Valves Seat Leakage (scim)	0	*
O$_2$H$_2$ Burner LH$_2$ System Leak Check		
Combined Burner LH$_2$ Prop Vlv & LOX Shutdown Valve Seat Leakage (scim)	0	*
Burner LH$_2$ Prop Valve Seat Leakage (scim)	0	0.7 max
LOX Prop Line Relief Valve Seat Leakage (scim)	0	0

Engine GG & Exhaust System Leak Checks

Function	Measurement	Limits
Engine Seal Leak Checks		
GG Fuel Purge Check Vlv Rev Lkg (scim)	0	25 max
LH$_2$ Turbine Seal Leakage (scim)	2200	6450 max
2nd E&M Value from J-2 Eng Log Book (scim)	3450	*
LOX Turbine Seal Leakage (scim)	10	350 max
Start Tnk Disch Vlv Gate Seal Leakage (scim)	2.2	20 max
GG & Exhaust System Leak Checks		
Oxid Turb Bypass Vlv Shaft Seal Lkg (scim)	0.25	10 max
Oxid Manifold Carr Flng Bleed (scim)	0.58	20 max
GG LOX Poppet Rev Leakage (scim)	300	*
GG LOX Purge Check Vlv Rev Lkg (scim)	0	15 max
Hydraulic Pump Shaft Seal Lkg (scim)	0	228 max
GG LOX & LH$_2$ Propellant Valve Seat Leak Checks		
GG LOX Prop Vlv Seat & Oxid Pump Shaft Seal Leakage (scim)	0	20 max
Combined GG LOX & LH$_2$ Prop Vlv Seat Lkg (scim)	0	*
GG LH$_2$ Prop Vlv Seat & Fuel Pump Shaft Seal Leakage (scim)	0	15 max

Engine Pump Purge Leak Checks

Function	Measurement	Limits
Pump Purge Module Internal Leak Checks		
Purge Valve Seat Leakage (scim)	5	12 max
Purge Discharge Pressure (psig)	90	67 to 110
Pump Purge Flow Checks		
GG Fuel Purge Flow (scim)	3875	2400 min
LOX Turbine Seal Purge Flow (scim)	3750	2400 min

* Limits Not Specified

4.1.9.1 (Continued)

Function	Measurement	Limits
LH_2 Turbine Seal Purge Flow (scim)	3875	2400 min
Fuel Pump Seal Cavity Purge Flow (scim)	1750	200 min

Engine Pneumatics Leak Checks

Function	Measurement	Limits
Helium Control Solenoid Energized Leak Checks		
Low Press Relief Vlv Seal Leakage (scim)	0	5 max
Low Press Relief Vlv Pilot Bleed Lkg (scim)	0	10 max
Fast Shutdown Vent Port Diaph Leakage (scim)	0	5 max
Press Act Purge Vlv Diaph Leakage (scim)	0	3 max
Int Pneu Sys Leakage (He Cont Sol On) (scim)	5.4	20 max
LOX Pump Intermediate Seal Purge Leak Checks		
Seal Leakage Pump Direction (scim)	62	*
Seal Leakage Turbine Direction (scim)	125	*
Seal Leakage Total (scim)	187	850 max
Seal Purge Check Vlv Overboard Flow (scim)	1150	*
Seal Purge Flow (scim)	1337	1300 to 3500
Ignition Phase Solenoid Energized Leak Checks		
Start Tnk Disch Vlv 4-Way Sol Seat Lkg (scim)	2.5	15 max
Start Tnk Disch Vlv Piston Seal Lkg (Closed Pos) (scim)	0	40 max
Internal Pneu Sys Lkg (Ign Phase Sol On) (scim)	3.5	20 max
Start Tank Discharge Valve Solenoid Energized Leak Checks		
STDV 4-Way Sol Seat Lkg (Energized) (scim)	1.8	15 max
STDV Piston Seal Lkg (Open Pos) (scim)	0	40 max
Mainstage Control Solenoid Energized Leak Check		
Press Act Fast Shutdown Vlv Seat Lkg (scim)	0	10 max
Int Pneu Sys Lkg (Mnstg Sol On) (scim)	10.8	20 max
Pressure Actuated Purge System Leak Check		
Press Act Purge Vlv Vent Seat Lkg (scim)	0	10 max
Press Act Purge Vlv Inlet Seat Lkg (scim)	0	10 max
Engine Control Bottle Fill System Leak Check		
Eng Cont Bot Fill Check Vlv Rev Lkg (scim)	0	3 max
Eng Cont Bot Decay Check (Delta M) (lb-mass/hr)	0.0354	0.036 max

* Limits Not Specified

4.1.9.1 (Continued)

LOX & LH_2 Vent System Leak Checks

Function	Measurement	Limits
LOX Vent System Leak Checks		
Combined LOX Vent & Relief Vlv & Relief Vlv Seat & Pilot Bleed Lkg (scim)	102	100 max
Combined LOX V&R Vlv & Relief Vlv Seat, Pilot Bleed Lkg (scim)	180	*
LOX Vent Boost Piston Seal Lkg (scim)	70	2420 max
LOX Vent Valve Open Act Seal Lkg (scim)	0	75 max
Propulsive Vent System Leak Checks		
Continuous Vent & Orifice Bypass Vlv Seat Lkg (scim)	0	16 max
Nonpropulsive Vent System Leak Checks		
Bidirect Vent Vlv Act Seal & Blade Shaft Seal Lkg - Flight Pos (scim)	0	3.5 max
Bidirect Vent Vlv Seat Lkg (Flt Pos) (scim)	0	50 max
Bidirect Vent Vlv Act Seal & Blade Shaft Seal Leakage - Ground Pos (scim)	0	3.5 max
Ground Vent System Leak Checks		
Combined LH_2 V&R Vlv, Relief Vlv Seat, & Pilot Bleed Lkg (scim)	3.2	150 max
Combined LH_2 V&R Vlv & Relief Vlv Seat, Pilot Bleed, & Boost Piston Seal Lkg (scim)	90	*
LH_2 V&R Vlv Boost Piston Seal Lkg (scim)	86.8	1725 max
LH_2 Vent Valve Open Act Seal Lkg (scim)	0	75 max
Bedirect Vent Vlv Seat Lkg (Gnd Pos) (scim)	0	50 max

* Limits Not Specified

4.1.10 Stage Power Turnoff (1B55814 C)

The stage power turnoff procedure was used for automatic shutdown of the stage power distribution system, returning the stage to the de-energized condition after completion of the various system checkout procedures during prefire testing of the stage. The procedure deactivated stage relays so that no current flowed from the battery simulators through the stage wiring. All internal/external transfer relays were set to the external condition.

To ensure that the procedure would deactivate the stage power, it was initially conducted on 11 September 1967, after the first application of power to the stage. The first attempt was not acceptable because of malfunction indications that resulted from missing wires in two stage cable harnesses, reference FARR A255448. After this was corrected, the procedure was repeated acceptably on 12 September 1967.

Automatic stage power turnoff started with verification that the umbilical connectors were mated and that the flight measurement indication enable was turned on. The bus 4D119 talkback power, the forward bus 1 and aft bus 1, 28 vdc power supplies, and the sequencer power were all verified to be on. The forward bus 1 and aft bus 1 voltages were then measured.

Switch selector functions were then turned off, and a series of checks verified that the stage electrical functions were in the proper state of off or reset. The forward and aft bus power supplies were verified as off, and the forward and aft bus battery simulator voltages were measured. Stage buses were then transferred to external power, and the forward and aft stage bus voltages were measured. The EBW pulse sensor power was turned off, and the range safety

4.1.10 (Continued)

receivers and EBW firing units were transferred to external power. The range safety system safe and arm device was verified to be on safe, and the bus 4D119 talkback power was turned off. The matrix magnetic latching relays were then reset, completing this demonstration run for stage power turnoff.

There were three revisions written to the procedure for the following:

a. One revision corrected a program error.

b. One revision explained that a malfunction printout was caused by missing wires in two stage cable harnesses. Ref: FARR A255448.

c. One revision authorized the rerun of this procedure to prove system and stage integrity after completion of rework per FARR A255448.

4.1.11 Hydraulic System Setup and Operation (1B41005 B)

The purpose of this manual procedure was to ensure that the hydraulic system was correctly filled, flushed, bled, and maintained free of contaminants during hydraulic system operation. The hydraulic system pressure and temperature were checked for proper operational levels, the hydraulic system transducers were tested for correct operation, and J-2 engine operational clearance in the aft skirt was established.

Prior to initiation of this test, the accumulator/reservoir, P/N 1B29319-519, S/N 00023, was removed and replaced with S/N 00034 per FARR A261644.

This test was initiated on 11 September 1967, and certified as complete on 6 October 1967. Proper operation of the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454588; the hydraulic actuator assemblies, P/N's 1A66248-505 -011, S/N's 51 and 53; the main hydraulic pump, P/N 1A66240-503, S/N X457808; and the accumulator/reservoir assembly, P/N 1B29319-519, **S/N 00023, were verified** during checkout activity. There were no part shortages affecting this test.

Prior to the start of the test, the hydraulic pumping unit (HPU), P/N 1A67443-1, was checked to ensure hydraulic fluid cleanliness. The HPU was connected to the stage, utilizing the pressure and return hoses, and the hydraulic fluid was circulated through the stage hydraulic system to ensure that the system was properly filled. Hydraulic fluid samples were taken and were certified to be free of contaminants. The accumulator/reservoir was charged with GN_2, and the stage air bottles were charged to a pressure of 475 $\pm$50 psig.

4.1.11 (Continued)

The HPU was turned on and the system pressure was set to between 4000 and 4400 psig. The stage hydraulic system was checked for leaks and was determined to be within design requirements. On completion of the leak check, the stage hydraulic system pressure was reduced to 1000 ± 50 psig. The auxiliary hydraulic pump was turned on and verified to be operating properly.

With the midstroke locks installed on the hydraulic actuators, the vernier scales were adjusted to read zero. The pitch and yaw command relays were disabled, the midstroke locks were removed, and the system hydraulic pressure was increased to 3650 ± 50 psig. The vernier scales were read and recorded, and the midstroke locks were reinstalled subsequent to reduction of the HPU pressure regulator and system pressure.

The engine deflection clearance check was accomplished next. The gimbal control unit (GCU) was installed, the protective covers were removed from the J-2 engine bellows, and the platform extension, P/N 1B70620, was removed from the engine area. The engine restrainer and the midstroke locks were removed from the engine. The stage hydraulic system pressure was established at 1000 psig. The pitch and yaw manual controls on the GCU were turned in the retract and extend directions. As the controls were moved, it was verified that the pitch and yaw actuators moved in relation to the direction and amplitude of the controls. After the J-2 engine was certified as cleared for gimbal tests, the HPU was secured, and the actuator midstroke locks and J-2 engine bellows were reinstalled.

4.1.11 (Continued)

Verification and setup of the stage and test control center hydraulic system instrumentation was started by turning on the HPU and adjusting the pressure compensator until the system hydraulic pressure gauge indicated the desired pressure readings. These readings were used to support verification of the system pressure for parameter D549. The reservoir oil level was checked at zero and one hundred per cent by parameter L504.

Preparations for the engine gimbal test were started by setting the pitch and yaw manual controls on the GCU to the center position and turning the GCU off. The HPU was turned off, the GCU was disconnected from the actuators, and the stage electrical cables were connected to the actuators. The midstroke locks were removed, and it was verified that the engine area was clear for engine gimbaling tests. The HPU was turned on, and the system pressure increased to 3650 $\pm$50 psig. Various signals were applied to the pitch and yaw actuators, and the resultant voltages were noted and recorded. Upon completion of this series of tests, the HPU was turned off, and the midstroke locks and J-2 engine bellows protective covers were reinstalled.

A check to determine the pressure decay of the stage air supply was next. The stage air bottles were charged to 442 psig. After a 24 hour period, the pressure was remeasured and found to be 442 psig.

An instrumentation setup was made to provide telemetry parameters for computer interrogation during the hydraulic system automatic checkout. Telemetry connections were made to the reservoir oil pressure transducer, the reservoir oil

4.1.11 (Continued)

level transducer, and the pump inlet temperature transducer. After completion of the hydraulic system automatic checkout, these parameters were disconnected, and the hardwire cables were reconnected.

The final engine deflection clearance check was accomplished next. This test provided for gimbaling the engine to its travel extremities and checking the clearance between engine, stage, and test stand structure, with particular emphasis on the clearance of the electrical cables. This section was not performed until the final cable installations and the wrapping had been completed. The GCU was reinstalled, and the engine bellows protective covers were removed. The test stand platform extension was removed from the engine area. The restrainer links and midstroke locks were removed. The auxiliary hydraulic pump was turned on and verified to be operating normally. The pitch manual control and the yaw manual control on the GCU were varied, and the engine deflection test was repeated. After completion of the test, the auxiliary hydraulic pump was turned off, the midstroke locks and bellows protective covers were reinstalled. The GCU was disconnected and removed, and the stage electrical connectors were reconnected to the actuators.

The simulated static firing support test was accomplished next. This checkout was required to simulate the engine driven hydraulic pump flow capabilities during simulated static firing. The HPU was turned on approximately 20 seconds prior to simulated engine start, and the hydraulic system pressure was set at 3700 psig. After simulated engine cutoff, the HPU was turned off.

4.1.11 (Continued)

No problems were encountered, and no FARR's were written as a result of this test. The procedure was accepted by Engineering on 6 October 1967.

Eleven revisions were made to the procedure for the following:

a. Five revisions reran sections of the procedure to obtain Engineering data.

b. Three revisions deleted sections no longer required.

c. One revision reran a section to support the DDAS automatic procedure.

d. One revision corrected an error in the procedure.

e. One revision was voided.

4.1.11.1 Test Data Table, Hydraulic System Setup and Operation

Test Description	Instrumentation Name	Instrumentation Location	Actual (in)	Required (in)
Actuator	Pitch Vernier	Pitch Actuator	0	0
	Yaw Vernier	Yaw Actuator	0	0
			Position	Voltage
Instrumentation Support	Pitch Actuator Position (deg.)	TCC	0	2.5152 vdc
			+1	2.5184 vdc
			+2	1.8014 vdc
			+1	2.1596 vdc
			0	2.5121 vdc
	Pitch Actuator Position (deg.)	TCC	0	2.8656 vdc
			-1	2.8657 vdc
			-2	3.2200 vdc
			-1	2.8668 vdc
			0	2.5150 vdc
	Yaw Actuator Position (deg.)	TCC	0	2.5410 vdc
			+1	2.8649 vdc
			+2	3.2005 vdc
			+1	2.5132 vdc
			0	2.5172 vdc

4.1.11.1 (Continued)

Test Description	Instrumentation Name	Instrumentation Location	Position	Voltage
	Yaw Actuator Position (deg.)	TCC	0	2.1647 vdc
			-1	2.1790 vdc
			-2	1.8369 vdc
			-1	2.1835 vdc
			0	2.1570 vdc
Stage Air Bottle Decay Check	Air Bottle Pressure	Stage	Start 02:30 a.m. 9-15-67	442 psig*
			Stop 03:00 9-16-67	442 psig*

* Limits Not Specified

4.1.12 Auxiliary Propulsion System (1B55825 C)

The auxiliary propulsion system test verified the integrity of the stage wiring associated with APS functions, and verified receipt of command signals routed from the GSE automatic checkout system, through the attitude control relay packages, to the APS electrical interfaces. The APS simulators, used in place of the APS flight modules for this test, did not functionally simulate the APS modules, but provided suitable loads at the electrical interface to determine that the stage mounted components of the APS functioned properly.

All stage mounted components of the APS were tested, in particular the attitude control relay packages, P/N 1B57731-1, S/N 353, at reference location 404A51A4 and S/N 352, at reference location 404A71A19. The procedure was satisfactorily accomplished and accepted on 11 September 1967.

After initial conditions were established, the GSE IU substitute -28 vdc power supply was turned on. The APS firing enable command and the APS bus power were turned on. A series of tests were then conducted to verify the proper operation of the APS engine valve solenoids. The attitude control nozzle commands were turned on, and the appropriate APS engine valve open indication was verified.

The attitude control nozzle command was then turned off, and the valve open indication was again verified. The 70 pound ullage engine commands 1 and 2 were then individually turned on and off, while the ullage engine relay reset was verified to operate properly. At the conclusion of these tests, the stage was returned to the pre-test configuration, thereby completing the test

4.1.12 (Continued)

procedure. The computer typeout indicated that the switch selector was used four times during this test run.

Engineering comments indicated that there were no part shortages that would affect this test. No problems were encountered during the test, no FARR's were written, nor were any revisions made to the procedure.

4.1.13 Power Distribution System (1B55814 E)

The automatic checkout of the stage power distribution system verified the capability of the GSE to control power switching to and within the stage, and determined that static loads within the stage were not excessive. The procedure verified that particular stage relays were energized or de-energized as required, and that bi-level talkback indications were received at the GSE. Static loading of the various stage systems or assemblies was determined by measuring the GSE supply current before and after turn-on of the system. All electrical components on the stage were involved in this test, including the point level sensors, the propellant utilization system, the auxiliary propulsion system, the J-2 engine ignition bus, the stage telemetry system, the stage power buses, the LOX and LH_2 chilldown inverters and the external to internal power transfer system.

The procedure was accomplished on 12 September 1967, and accepted by Engineering on 13 September 1967.

The stage power setup H&CO was accomplished, establishing initial conditions for the test. To verify that the power supply and stage buses were operating properly, measurements were made of the engine control bus current and voltage, the APS bus current, the engine ignition bus current and voltage with the bus on, and voltage with the bus off, the component test power current and voltage with the power on, and with the component test power turned off. For a check of the emergency detection systems (EDS), it was verified that the EDS 2 engine cutoff signal turned off the engine control

4.1.13 (Continued)

bus power and prevented it from being turned back on, and also turned on the instrument unit range safety 1 EBW firing unit arm and engine cutoff signal. The engine control bus voltage was measured during this check, and again with the bus turned back on. Verification was then made that the EDS 1 engine cutoff signal turned on the nonprogrammed engine cutoff signal and the AO multiplexer engine cutoff signal indication (K13); and that with the EDS 1 signal turned off, the engine ready bypass turned off both cutoff indications.

For the point level sensor test, the propellant level sensor power current was measured, and each of the LH_2 tank and LOX tank point level sensors were verified to respond properly within 300 milliseconds to the simulated wet conditions. A series of checks then verified that a dry condition indication from any two point level sensors in either tank, obtained by simulated wet condition off commands, resulted in the required engine cutoff signal. For the dry condition of LOX tank sensors 1 and 2, the engine cutoff LOX depletion timer value was measured to determine the cutoff signal delay time. Each of the point level sensors was then verified to respond properly within 300 milliseconds to simulated wet condition off commands.

Verification was then made that the engine cutoff command turned on the AO multiplexer engine cutoff signal indication (K13), the engine cutoff command indication (K140), and the engine cutoff, but did not turn on the nonprogrammed engine cutoff indication. With the engine cutoff command turned off, it was verified that the engine cutoff command indication was off while the multiplexer engine cutoff indication and the engine cutoff remained on, until turned off by the engine ready bypass.

4.1.13 (Continued)

The propellant utilization inverter and electrical power current was measured while the power was momentarily turned on. The PCM RF assembly power current was then measured, and the PCM/FM transmitter output power was measured through the AO and BO multiplexers. With the telemetry RF silence command turned on, the RF group was verified to be off, the PCM/FM transmitter output power was measured through the AO multiplexer, and the switch selector output monitor voltage (K128), was measured with the PCM RF assembly power and the switch selector commands 1 and 2 turned on. With the telemetry RF silence command turned off, the RF group was verified to be on, and the PCM/FM transmitter power was again measured through the AO multiplexer.

The rate gyro voltages were manually verified to be 28 $\pm$ 2.0 vdc with the gyro turned on, and 0.0 $\pm$ 2.0 vdc with the gyro turned off. The environmental control group current was measured while the group was momentarily turned on. The aft bus 2 current and voltage were then measured, and the aft bus 2 power supply local sense indication was verified to be off.

For the chilldown inverter tests, the chilldown pump simulator was connected to the LOX and LH_2 chilldown inverters, and for each inverter, measurements were made of the input current, the output voltages through both hardwire and telemetry, and the operating frequency, through telemetry.

A series of checks then verified the operation of the external/internal transfer system for forward bus 1 and 2, and aft bus 1 and 2. The battery simulator voltages and the electrical support equipment load bank voltages were measured first. The power bus voltages were then measured with the

4.1.13 (Continued)

buses transferred to internal, and the bus local sense indications were verified to be off. The bus voltages were measured again with the buses transferred back to external, and the battery simulator voltages were measured with the simulators turned off. The aft bus 2 voltage was then measured with the bus power supply turned off.

Verification was made that the switch selector register was operating properly and that the instrument unit 28 vdc power supplies were on. The range safety receivers currents were measured with the receivers transferred to external power and momentarily turned on. The range safety system EBW firing units were verified to be on, when they were transferred to external power and momentarily turned on. This completed the power distribution system test. The computer printout indicated that the range safety receivers and decoders had accumulated 9.785 seconds of running time during this test run, and that the switch selector had been used 36 times.

Engineering comments indicated that there were no parts shortages affecting the checkout. No problems were encountered during the test, and no FARR's were written against the procedure. Seven revisions were made to the procedure for the following:

a. One revision changed the program to allow for a current surge of 3 seconds for forward bus 2, after turn-on of the PU inverter.

b. Two revisions deleted a series of steps to update the procedure.

c. One revision gave instructions to place the LOX and LH_2 inverters in a safe condition by disconnecting the power input cables.

4.1.13 (Continued)

d. Three revisions explained that malfunction printouts were acceptable because a valve enable circuit was off for leak checks, the LOX inverter was in a safe condition and the program was in a backup routine, which failed to turn on the aft bus.

4.1.13.1 Test Data Table, Power Distribution System

Function	Measurement	Limits
Engine Control Bus Current (amps)	0.200	2.0 + 2.0
Engine Control Bus Voltage (vdc)	28.122	28.0 ∓ 2.0
APS Bus Current (amps)	0.000	1.5 ∓ 3.0
Engine Ignition Bus Current (amps)	0.000	0.0 ∓ 2.0
Engine Ign Bus Voltage, Bus on (vdc)	28.275	28.0 ∓ 2.0
Engine Ign Bus Voltage, Bus off (vdc)	-0.030	0.0 ∓ 2.0
Component Test Power Current (amps)	0.300	0.0 ∓ 2.0
Component Test Power Voltage (vdc)	28.158	28.0 ∓ 2.0
Engine Control Bus Volt EDS 2 on (vdc)	0.000	0.0 ∓ 2.0
Engine Control Bus Volt EDS 2 off (vdc)	28.091	28.0 ∓ 2.0
Propellant Level Sensor Pwr Current (amps)	0.199	1.0 ∓ 2.0
Engine Cutoff LOX Depletion Timer (sec)	0.569	0.560 ∓ 0.025
PU Inverter & Elec Pwr Current (amps)	4.000	3.0 ∓ 2.0
PCM RF Assy Power Current (amps)	4.700	4.5 ∓ 3.0
PCM/FM Transmitter Output Pwr AO (watts)	28.250	10.0 min
PCM/FM Transmitter Output Pwr BO (watts)	18.226	10.0 min
PCM/FM Transmitter Output Pwr (RF Silence on) (watts)	-0.118	0.0 + 1.0
Switch Select Output Monitor (K128) (vdc)	2.169	2.0 ∓ 1.0
PCM/FM Transmitter Output Pwr (RF Silence off) (watts)	28.255	10.0 min
Environ Control Group Current (amps)	0.200	0.0 + 2.0
Aft Bus 2 Current (amps)	0.600	5.0 max
Aft Bus 2 Voltage (vdc)	57.838	56.0 ± 4.0

4.1.13.1 (Continued)

Chilldown Inverter Tests

Function	LOX Inv	LH_2 Inv	Limits
Inverter Current (amps)	19.399	20.399	22.0 ± 5.0
Phase AB Voltage, Hardwire (vac)	53.193	54.105	55.6 + 2.0,-4.5
Phase AC Voltage, Hardwire (vac)	53.584	54.105	55.6 + 2.0,-4.5
Phase A1B1 Voltage, Hardwire (vac)	53.063	53.323	55.6 + 2.0,-4.5
Phase A1C1 Voltage, Hardwire (vac)	53.845	54.105	55.6 + 2.0,-4.5
Phase AB Voltage, Telemetry (vac)	55.331	55.465	55.6 ± 3.0
Phase AC Voltage, Telemetry (vac)	55.932	55.398	55.6 ± 3.0
Frequency, Telemetry (Hz)	400.100	400.100	400.0 ± 4.0

Function	Measurement	Limits
Fwd Bus 1 Battery Simulator Volt(vdc)	28.60	28.0 ± 2.0
Fwd Bus 2 Batt Simulator Volt (vdc)	26.68	28.0 ± 2.0
Aft Bus 1 Batt Simulator Volt (vdc)	28.12	28.0 ± 2.0
Aft Bus 2 Batt Simulator Volt (vdc)	56.24	56.0 ± 4.0
Bus 4D20 ESE Load Bank Volt (vdc)	0.00	0.0 ± 1.0
Bus 4D40 ESE Load Bank Volt (vdc)	0.00	0.0 ± 1.0
Bus 4D30 ESE Load Bank Volt (vdc)	0.04	0.0 ± 1.0
Bus 4D10 ESE Load Bank Volt (vdc)	0.00	0.0 ± 1.0
Fwd Bus 1 Internal Voltage (vdc)	28.44	28.0 ± 2.0
Fwd Bus 2 Internal Voltage (vdc)	26.52	28.0 ± 2.0
Aft Bus 1 Internal Voltage (vdc)	28.20	28.0 ± 2.0
Aft Bus 2 Internal Voltage (vdc)	56.32	56.0 ± 4.0
Fwd Bus 1 External Voltage (vdc)	28.48	28.0 ± 2.0
Fwd Bus 2 External Voltage (vdc)	26.64	28.0 ± 2.0
Aft Bus 1 External Voltage (vdc)	28.08	28.0 ± 2.0
Aft Bus 2 External Voltage (vdc)	56.16	56.0 ± 4.0
Fwd Bus 1 Batt Simulator Volt (vdc)	0.08	0.0 ± 1.0
Fwd Bus 2 Batt Simulator Volt (vdc)	0.00	0.0 ± 1.0
Aft Bus 1 Batt Simulator Volt (vdc)	0.04	0.0 ± 1.0
Aft Bus 2 Batt Simulator Volt (vdc)	0.00	0.0 ± 1.0
Aft Bus 2 Voltage (vdc)	0.00	0.0 ± 1.0
Range Safety Rec 1 Current (amps)	-0.500	0.0 ± 2.0
Range Safety Rec 2 Current (amps)	-1.501	0.0 ± 2.0

4.1.14 Telemetry and Range Safety Antenna System Check (1B44472 C)

This test procedure verified the operational capabilities of the telemetry and range safety antenna system by determining that the continuities, VSWR's insertion losses, phasing and power levels of the systems were within the required limits. In addition, the center frequency and carrier deviation of the PCM transmitter were determined to be within tolerance limits, and the operation of the PCM RF assembly and the FM/FM group power functions were checked.

Listed below are the components of the range safety systems involved in this test:

Part Name	P/N	Reference Location	S/N
PCM RF Assembly	1B52721-521	411A64A200	034
Bi-Directional Coupler	1A69214-503	411A64A204	083
Coaxial Switch	1A69213-1	411A64A202	0064
Power Dividers	1A69215-501	411A64A201	044
Telemetry Antennas	1A69206-501	411E200 & E201	050 & 054
Reflected Power Det.	1A74776-501	411MT744	285
Forward Power Det.	1A74776-503	411MT728	2-0200
Dummy Load	1A84057-1	411A64A203	660
Directional Power Divider	1B38999-1	411A97A56	033
Hybrid Power Detector	1A74778-501	411A97A34	041
Range Safety Antennas	1A69207-501	411E56 & E57	044 & 043
Range Safety Receivers	501M10697	411A97A14 & A18	172 & 166

The checkout was accomplished in two issues. Issue number one was initiated on 13 September 1967 and completed on 25 September 1967. Issue number two, accomplished on 3 October 1967, was used to evaluate an out-of-tolerance VSWR problem reported on FARR A261634, which was generated during the DDAS automatic test procedure. The out-of-tolerance condition was determined to have been caused by a loose RF cable connector.

4.1.14 (Continued)

Before the tests were started, a test cable, P/N 1B50922-1, was calibrated at 258.5 ±0.1 MHz for use during this checkout. Cable insertion loss measurements were made of the telemetry system transmission lines from the transmitter output of the PCM RF assembly to the input of each telemetry antenna, one at a time, with the opposite antenna replaced by a 50 ohm dummy load. The phase difference of the transmission lines from the outputs of the power divider to the telemetry antenna inputs was measured with the antennas replaced by short circuit terminations.

The VSWR's of the transmission lines from the power divider to the antennas were then measured with the antennas reconnected. The coaxial switch was energized, and the telemetry system closed loop VSWR was measured from the transmitter output to the dummy load. The coaxial switch was then de-energized, and the telemetry system open loop VSWR was measured from the transmitter output to the antennas.

The dummy load was connected to the output of the PCM transmitter, and stage power was turned on to the PCM RF assembly. Measurements were made of the transmitter carrier center frequency and carrier deviation. The transmitter RF output power into the dummy load was measured. The output of the forward power detector was measured and verified to be within ±3 per cent of the detector calibration requirements for the transmitter output power. For calibration of the refelcted power detector, the forward power detector output was measured, and the equivalent forward power was determined from the detector calibration. The reflected power was measured and verified to be 11 ±1 per

4.1.14 (Continued)

cent of the forward power. The output of the reflected power detector was then measured and verified to be within ±3 per cent of the detector calibration requirement for the measured reflected power.

A final check verified that the forward bus 1 current did not increase when either the PCM RF assembly power or the FM/FM group power was turned on, and that the RF silence command would cut off the RF assembly power.

Engineering comments noted that all parts were installed at the start of the test. At the beginning of the test, per the first issue, the PCM RF assembly, P/N 1B52721-509, S/N 033, was rejected on FARR A261605 for excessive output voltage. The output was 26 watts, but it should have been within 20 ±5 watts. The assembly, S/N 033, was removed and replaced with S/N 034. No other discrepancies were recorded during the operation of this procedure.

Twelve revisions were made to issue 1 and nine revisions were made to issue 2 for the following:

Issue 1

a. Four revisions reran previously accomplished sections to troubleshoot for a high VSWR reading.

b. Four revisions changed, added, or deleted requirements that were in error or missing.

c. Three revisions changed the list of required equipment so that available equivalent equipment could be used.

d. One revision reran a section to check out the replacement PCM RF transmitter.

4.1.14 (Continued)

Issue 2

a. Three revisions concerned a rerun of several sections to investigate a high VSWR reading.

b. Three revisions reran previously run sections to obtain engineering data.

c. Two revisions changed the list of required equipment so that available equivalent equipment could be used.

d. One revision deleted a section of the test that had been previously run.

4.1.14.1 Test Data Table, Telemetry and Range Safety Antenna System

Function	Measurement	Limits
Test Cable Calibration		
VSWR at 258.5 MHz	14.5	*
Telemetry System Tests		
Insertion Loss to Antenna 1 (db)	5.0	6.7 max
Insertion Loss to Antenna 2 (db)	5.3	6.7 max
Antenna Line Phase Difference (deg)	25.2	30.0 max
VSWR to Antenna 1	1.23	1.7 max
VSWR to Antenna 2	1.47	1.7 max
System Closed Loop VSWR	1.47	1.5 max
System Open Loop VSWR	1.42	1.7 max
PCM Transmitter RF Tests		
Center Frequency (MHz)	258.497	258.500 ± 0.026
Carrier Deviation (kHz)	37.5	36.0 ± 3.0
Output Power (watts)	22.8	20.0 ± 5.0
Forward Power Detector Output (mv)	104.7	*
Forward Power Detector Output (mv)	84.0	*
Equivalent Forward Power (watts)	18.3	*
Reflected Power (watts)	2.05	1.83 to 2.20
Reflected Power Detector Output (mv)	6.75	6.55 to 6.95

*Limits Not Specified

4.1.15 Level Sensor and Control Unit Calibration (1B44473 D)

This manual procedure determined that the control units associated with the LOX and LH_2 liquid level, point level, fast fill, and overfill sensors, were adjusted for operating points within the design calibration limits. The particular items involved in this test are noted in Test Data Table 4.1.15.1. The procedure was satisfactorily accomplished on 15 September 1967, and was accepted on the same date.

A point level sensor manual checkout assembly, P/N 1B50928-1, and a variable precision capacitor, General Radio Type 1422CD, were connected in parallel with the sensor to provide capacitance changes to each control unit to simulate sensor wet conditions for calibrations, and to establish the control unit operating points. These calibration capacitances were 0.7 $\pm$0.01 picofarads for all LH_2 sensors, except the LH_2 overfill sensor, which required 1.1 $\pm$0.02 picofarads; and 1.5 $\pm$0.02 picofarads for all LOX sensors, except the LOX overfill sensor, which required 2.1 $\pm$0.02 picofarads. With the control unit power turned on, the control unit control point adjustment R1 was adjusted until the control unit output signal changed from 0 $\pm$1 vdc to 28 $\pm$2 vdc, indicating activation of the control unit output relay. The capacitance of the precision capacitor was then decreased until the control unit output signal changed to 0 $\pm$1 vdc, indicating deactivation of the control unit output relay, and then increased until the output signal changed back to 28 $\pm$2 vdc, indicating reactivation of the output relay. The deactivation and reactivation capacitance values were recorded in Test Data Table 4.1.15.1 with the appropriate minimum and maximum capacitance limits.

4.1.15 (Continued)

A series of checks then verified the operation of the output relay test function. With the associated sensor disconnected, the control unit output relay was verified to be deactivated under both normal and test conditions, while with the sensor connected, the relay was verified to be deactivated under normal conditions, and activated under test conditions.

There were no parts shortages that affected this test. No problems were encountered during the test, nor were any FARR's written. One revision was made to the procedure to change the calibration capacitance for the LH_2 tank fast fill sensor to 0.8 pf, and the LH_2 tank overfill sensor to 1.2 pf to enable the operating point to be set nearer to the maximum activation point.

4.1.15.1 Test Data Table, Level Sensor and Control Unit Calibration

	Sensor P/N 1A68710			Control Unit P/N 1A68710			Deactivate Cap (pf)		Reactivate Cap (pf)	
Function	Ref. Loc.	Dash P/N	S/N	Ref. Loc.	Dash P/N	S/N	Meas	Min	Meas	Max
LH_2 Tank	408			411						
Liq Lev L17	MT732	-507	D72	A61A217	-509	D99	0.665	0.5	0.666	0.9
Liq Lev L18	MT733	-507	D76	A61A219	-509	D27	0.6923	0.5	0.6928	0.9
Liq Lev L19	MT734	-1	D119	A61A221	-509	D95	0.6813	0.5	0.6816	0.9
Pt Lev 1	A2C1	-507	D74	A92A25	-509	D118	0.668	0.5	0.669	0.9
Pt Lev 2	A2C2	-507	D77	A92A26	-509	D117	0.693	0.5	0.694	0.9
Pt Lev 3	A2C3	-507	D80	A92A27	-509	C6	0.690	0.5	0.692	0.9
Pt Lev 4	A2C4	-507	D83	A61A201	-509	D120	0.673	0.5	0.674	0.9
Fastfill	A2C5	-1	D89	A92A43	-509	D121	0.7727	0.5	0.7728	0.9
Overfill	*	*	*	A92A24	-509	D116	1.163	0.9	1.165	1.3

* Part of LH_2 Mass Probe, P/N 1A48431-509, S/N D4, Location 408A1

4.1.15.1 (Continued)

	Sensor P/N 1A68710			Control Unit P/N 1A68710			Deactivate Cap (pf)		Reactivate Cap (pf)	
Function	Ref. Loc.	Dash P/N	S/N	Ref. Loc.	Dash P/N	S/N	Meas	Min	Meas	Max
LOX Tank	406			404						
Liq Lev L14	MT657	-1	D82	A63A223	-511	D82	1.484	1.3	1.492	1.7
Liq Lev L15	MT658	-1	D78	A63A206	-511	D122	1.469	1.3	1.470	1.7
Liq Lev L16	MT659	-1	D76	A63A223	-511	D121	1.480	1.3	1.483	1.7
Pt Lev 1	A2C1	-1	D105	A72A1	-511	D104	1.412	1.3	1.416	1.7
Pt Lev 2	A2C2	-1	D122	A72A2	-511	D98	1.470	1.3	1.472	1.7
Pt Lev 3	A2C3	-1	D124	A72A3	-511	D96	1.480	1.3	1.484	1.7
Pt Lev 4	A2C4	-1	D129	A63A227	-511	D126	1.446	1.3	1.450	1.7
Fastfill	A2C5	-1	D90	A72A5	-511.1	C16	1.440	1.3	1.443	1.7
Overfill	**	-1	**	A72A4	-511.1	D128	2.075	1.9	2.079	2.3

** Part of LOX Mass Probe, P/N 1A48430-511, S/N D9, Location 406A1

4.1.16 Propellant Utilization System Calibration (1B64368 D)

This manual calibration procedure verified the operation of the propellant utilization system and provided the necessary calibration prior to the automatic checkout of the system. For calibration purposes, the propellant utilization test set (PUT/S), P/N 1A68014-1, was used to provide varying capacitance inputs to the propellant utilization electronics assembly (PUEA) to simulate the LOX and LH_2 mass probe outputs under varying propellant load conditions. The items involved in this test included the following:

Part Name	Ref. Location	P/N	S/N
Propellant Utilization Electronic Assembly	411A92A6	1A59358-529	22
Static Invertor-Convertor	411A92A7	1A66212-507	25
LOX Mass Probe	406A1	1A48430-511	D9
LH_2 Mass Probe	408A1	1A48431-509	D4
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511.1	D128
LOX Fastfill Sensor	406A2C5	1A68710-1	D90
LOX Fastfill Control Unit	404A72A5	1A68710-511.1	C16
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D116
LH_2 Fastfill Sensor	408A2C5	1A68710-1	D89
LH_2 Fastfill Control Unit	411A92A43	1A68710-509	D121

The first issue of the calibration procedure was accomplished on 15 and 16 September 1967; however, it was necessary to perform a second issue because the LOX and LH_2 bridge linearity checks were out-of-tolerance due to calibration errors in issue one. The second issue was accomplished on 16 September 1967 and accepted on 18 September 1967. Measurements and ratiometer settings made during the test appear in Test Data Table 4.1.16.1.

Atmospheric conditions in the test area were measured before the calibration was started. Megohm resistance measurements were made on the LH_2 and LOX mass

4.1.16 (Continued)

probe elements through connector 411W11P1 at the PUEA, using a 50 vdc megohmeter. The PUT/S was connected to the PUEA; then, the static inverter-converter and the stage power for these units was manually turned on. The static inverter-converter voltages and operating frequency were then measured.

The PUEA bridge calibrations were conducted next. Simulated empty conditions were established with the PUT/S, and the PUEA LH_2 and LOX bridge empty condition calibrations were accomplished by nulling the bridge tap voltages with the PUT/S ratiometer, at settings of 0.01391 for the LH_2 bridge and 0.04027 for the LOX bridge; then, the bridge outputs were nulled by adjusting the PUEA R2 potentiometer for the LH_2 bridge and the PUEA R1 potentiometer for the LOX bridge. Simulated full conditions were then established with the PUT/S using a C1 capacitor (LH_2) setting of 182.33 picofarads and a C2 capacitor (LOX) setting of 122.67 picofarads, and the ratiometers were set to 0.82304 for the LH_2 bridge and 0.82555 for the LOX bridge. To accomplish the PUEA LH_2 and LOX bridge full calibrations, the bridge outputs were nulled by adjusting the PUEA R4 potentiometer for the LH_2 bridge and the PUEA R3 potentiometer for the LOX bridge.

Data acquistion was verified by establishing simulated empty and full conditions with the PUT/S, and adjusting the PUT/S ratiometer to null the PUEA LH_2 and LOX bridge outputs. Bridge slew checks were conducted by establishing simulated 1/3 and 2/3 slew conditions with the PUT/S, and adjusting the PUT/S ratiometer to null the PUEA LH_2 and LOX bridge outputs for each condition.

4.1.16 (Continued)

For the reference mixture ratio (RMR) calibration, the difference between the previously determined LH_2 and LOX empty ratiometer settings, 0.02643, was multiplied by 98.4 vdc to give a V1 reference voltage of 2.601 vdc. Simulated empty conditions were established with the PUT/S, and the PUEA residual empty bias R6 potentiometer was adjusted to null the RMR bias voltage. Simulated full conditions were then established with the PUT/S, and the PUEA residual full bias R5 potentiometer was adjusted to null the RMR bias voltage. For a fuel boiloff bias calibration, simulated boiloff conditions were established with the PUT/S, using a C1 capacitor (LH_2) setting of 202.30 picofarads and a C2 capacitor (LOX) setting of 122.67 picofarads. The PUEA fuel bias R7 potentiometer was then adjusted to null the RMR bias voltage.

PUEA LH_2 and LOX bridge linearity checks were accomplished by individually setting the PUT/S C1 capacitor (LH_2) and C2 capacitor (LOX) to specific values, and adjusting the PUT/S ratiometer to null the appropriate PUEA bridge output.

For a fuel boiloff bias data acquisition check, the RMR bias voltage was measured as 2.5671 vdc under simulated empty conditions, and a 9.9717 vdc under bias internal test conditions. The fuel boiloff bias voltage was the difference between these measurements, 7.4046 vdc.

The hardwire loading circuits were checked by establishing simulated full conditions with the PUT/S, setting the PUT/S ratiometer to 0.00000, and measuring the hardwire loading circuit PUEA LH_2 and LOX bridge output voltages. The LH_2 voltage was 22.51 vdc and the LOX voltage was 22.57 vdc, meeting the 23.52 $\pm$2.0 vdc requirements.

4.1.16 (Continued)

Three revisions were made to the procedure for the following:

a. One revision, to issue one, deleted the LH_2 and LOX bridge linearity checks. These checks were to be accomplished in issue two.

b. One revision, to issue two, deleted all of the procedure, except the LH_2 and LOX bridge linearity check which re-required reverification due to calibration errors in issue one.

c. One revision, to issue two, accepted the tank content composition taken during issue one, as the tanks had not been vented after the first issue.

4.1.6.1 Test Data Table, Propellant Utilization System Calibration

Pre-Test Atmospheric Conditions

Temperature:	$90^{o}F$
Pressure:	29.7 inches of Hg
Relative Humidity:	32 per cent

LH_2 Mass Probe Megohm Check - Plug 411W11P1

Function	Resistance (megohms)	Limits (megohms)
LH_2 Probe Elements, Pins G to E	200 k	1000 min
Pin G to Shield	200 k	1000 min
Pin G to Stage Ground	Inf	1000 min
Pin G Shield to Stage Ground	Inf	1000 min
Pin E to Stage Ground	Inf	1000 min

LOX Mass Probe Megohm Check - Plug 411W11P1

LOX Probe Elements, Pin A to C	200 k	1000 min
Pin C to Shield	200 k	1000 min
Pin C to Stage Ground	Inf	1000 min
Pin C Shield to Stage Ground	Inf	1000 min
Pin A to Stage Ground	Inf	1000 min

Static Inverter-Converter Measurements

Function	Measurement	Limits
5.0 vdc Output Voltage (vdc)	4.966	4.50 to 5.10
21.0 vdc Output Voltage (vdc)	21.269	20.00 to 22.50

4.1.16.1 (Continued)

Function	Measurement	Limits
28.0 vdc Output Voltage (vdc)	27.172	26.00 to 30.00
117 vdc Output Voltage (vdc)	118.98	115.00 to 122.50
115 vrms Monitor Voltage (vdc)	2.714	2.23 to 3.18
Test Point 2 Voltage (vdc)	21.301	20.00 to 22.5
V/P Excitation Voltage (vdc)	49.494	48.56 to 51.68
Operating Frequency (Hz)	401.00	394.00 to 406.00

Data Acquisition

Function	PUT/S Ratiometer	Limits
LH_2 Empty	0.01386	*
LOX Empty	0.04029	*
LH_2 Full	0.82293	*
LOX Full	0.82545	*
Bridge Slew Checks		
LH_2 1/3 Slew	0.30889	*
LH_2 2/3 Slew	0.63667	*
LOX 1/3 Slew	0.28395	*
LOX 2/3 Slew	0.57206	*

LH_2 Bridge Linearity Check

PUT/S C1 Value	PUT/S Ratiometer	Limits
36.47 pf	0.15970	0.15796 to 0.16126
72.93 pf	0.32576	0.32379 to 0.32709
109.20 pf	0.49125	0.48967 to 0.49297
145.86 pf	0.65744	0.65551 to 0.65881
182.33 pf	0.82302	0.82139 to 0.82469

LOX Bridge Linearity Check

PUT/S C2 Value	PUT/S Ratiometer	Limits
24.53 pf	0.18171	0.17998 to 0.18328
49.07 pf	0.34166	0.34096 to 0.34426
73.60 pf	0.50247	0.50194 to 0.50524
98.13 pf	0.66338	0.66292 to 0.66622
122.67 pf	0.82527	0.82390 to 0.82720

* Limits Not Specified

4.1.17 Digital Data Acquisition System Calibration (1B55816 E)

The performance of this procedure was necessitated by the removal of the remote digital submultiplexer (RDSM), P/N 1B52894-1, S/N 08, per FARR A261603. The procedure provided the manual and automatic operations for the calibration and checkout of the replacement RDSM, S/N 20, location 404A60A200.

The checkout was conducted on 16 September 1967, and accepted on 18 September 1967. After verifying that initial conditions were established, the digital data acquisition system (DDAS) ground station was verified to be in synchronization with the stage DDAS.

For testing of the RDSM, the required manual test cable connections were made; and when called for by the computer, the multiplexer input signal power supply was adjusted to voltage levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc for the five test runs on this multiplexer. During the 0.000 vdc input level test run, input voltages of 4.50 ±0.100 vdc and 20.00 ±1.0 vdc were supplied to the PCM/DDAS assembly. During the four other test runs, the respective inputs were 0.0 ±0.100 vdc and 0.0 ±1.0 vdc. At the start of this test, a malfunction typeout statement indicated no output voltage on channel CP1-B0-09-01. Subsequent investigation revealed that an incorrect test setup had been made, and no input voltage had been applied to the RDSM. The test setup was corrected, and the test was successfully completed with no malfunctions.

The engineering status review stated that an IUM pressure transducer, P/N 1A72913-539, S/N 240-1, was installed at the start of this test. This IUM part did not affect any portion of this checkout.

4.1.17 (Continued)

No FARR's were written as a result of this test; however, four revisions were written to the procedure for the following:

a. One revision authorized performance of the CP1-BO RDSM test for RDSM, S/N 20 only. All other sections of the test were deleted.

b. One revision changed the program to turn off the PCM system group power during the test setup connections on the stage.

c. One revision explained that a malfunction on channel CP1-BO-09-01 was caused by an incorrect test setup connection.

d. One revision stated that the four safety item monitor interrupts were caused by the parallel performance of the leak check procedure, 1B71877.

4.1.18 Propellant Utilization System (1B55823 F)

This automatic checkout procedure verified the capability of the propellant utilization system to determine and control the engine propellant flow mixture ratio to ensure simultaneous propellant depletion, and to provide propellant level information to control the fill and topping valves during LOX and LH_2 loading. This test involved all components of the stage propulsion utilization system including the propellant utilization valve in the J-2 engine and the following:

Part	Ref. Location	P/N	S/N
Propellant Utilization Electronics Assembly (PUEA)	411A92A6	1A59358-529	022
Static Inverter-Converter	411A92A7	1A66212-507	025
LOX Mass Probe	406A1	1A48430-509	D-9
LH_2 Mass Probe	408A1	1A48431-505	D-4
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511.1	D128
LOX Fast Fill Sensor	406A205	1A68710-1	D90
LOX Fast Fill Control Unit	406A72A5	1A68710-511.1	C16
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D116
LH_2 Fast Fill Sensor	408A2C5	1A68710-1	D89
LH_2 Fast Fill Control Unit	411A92A43	1A68710-509	D121

The procedure was initiated and completed on 16 September 1967, with certification occurring on 18 September 1967. The operation and test results of this checkout are discussed in this paragraph and Test Data Table 4.1.18.1.

After initial conditions were established, ratio values were obtained from the manual propellant utilization system calibration procedure, H&CO 1B64368, and loaded into the computer. From these ratio values, nominal test values were computed for LOX and LH_2 coarse mass voltages, fine mass voltages, and loading voltages. The PU system power test was conducted first. Power was applied

4.1.18 (Continued)

to the PU inverter and electronics, then the forward bus 2 voltage and the static inverter-converter output voltages and operating frequency were measured.

The servo balance and ratio valve null test was conducted next. The ratio valve position was measured, and the LOX and LH_2 coarse and fine mass voltages were measured through the AO and BO instrumentation multiplexers.

The PU loading test followed. The LH_2 boiloff bias signal voltage was measured with the boiloff bias cutoff turned on, and was verified to be 0.0 $\pm$2.5 vdc with the cutoff turned off. The GSE loading potentiometer power was turned on, and the voltage measured. Measurements were then made of the LOX and LH_2 loading potentiometer sense voltages and signal voltages. Measurements of the LOX and LH_2 loading potentiometer signal voltages were repeated after the LOX and LH_2 bridge 1/3 checkout relay commands were turned on, and again after these commands were turned off. The GSE power was turned off, and the LOX and LH_2 loading potentiometer sense voltages were again measured.

The servo balance bridge gain test was conducted next. The first attempt resulted in a malfunction printout because an operator did not wait a sufficient length of time for the PU oven temperature to stabilize. After a 30 minute delay, to allow the PU oven temperature to stabilize, the test was resumed and successfully completed. The ratio valve position was measured, and the LOX and LH_2 coarse and fine mass voltages were measured through the AO and BO telemetry multiplexers. The measurements were repeated with the LOX and LH_2 bridge 1/3 checkout relays on, with the bridge 2/3 checkout relays on, with the bridge 2/3 checkout relays off, and again with the bridge 1/3 checkout relays off.

4.1.18 (Continued)

The next check verified that the LOX and LH_2 tank overfill and fast fill sensors and their associated control units responded properly under ambient (dry) conditions and under simulated wet conditions of the sensors.

The valve movement test next measured the ratio valve positions during the 50 second plus valve slew and the valve positions during the 50 second minus valve slew.

The next part of this procedure was the PU activate test. All measurements for this test were made through the AO and BO multiplexers. The ratio valve position was measured, then the LOX bridge 1/3 checkout relay command was turned on and the LOX coarse mass voltage was measured. The ratio valve position was remeasured with the PU activate switch turned on and again with it turned off. The LOX bridge 1/3 checkout relay command was turned off, then the LOX coarse mass voltage and the ratio valve position were measured. These steps were then repeated using the LH_2 bridge 1/3 checkout relay, and measuring the LH_2 coarse mass voltage.

For a final test, the PU valve hardover position command was turned on, and the PU system ratio valve position was measured as -27.2 degrees with the LOX bridge 1/3 checkout relay command and the PU activate switch both on. This measurement complies with the less than -20 degrees requirement.

At the completion of this checkout, it was noted that the inverter-converter and PU power had been on 59 minutes 2.537 seconds, that the switch selector had been used 12 times, and that the LOX and LH_2 bridge potentiometers had been cycled 4 times and 3 times, respectively.

4.1.18 (Continued)

Engineering comments noted that all parts were installed at the start of this test. No FARR's were written as a result of this test. One revision was made to the procedure to explain that the out-of-tolerance conditions of the LOX and LH_2 fine mass voltages were caused by an operator not allowing sufficient time for the PU oven temperature to stabilize.

4.1.18.1 Test Data Table, Propellant Utilization System

Loaded Ratio Values (From H&CO 1B64368)

LOX Empty Ratio	0.020	LOX 1/3 Bridge Slew Ratio	0.284
LH_2 Empty Ratio	0.000	LOX 2/3 Bridge Slew Ratio	0.572
LH_2 Boiloff Bias Voltage	7.400	LH_2 1/3 Bridge Slew Ratio	0.309
LOX Wiper Ratio	0.040	LH_2 2/3 Bridge Slew Ratio	0.637
LH_2 Wiper Ratio	0.014		

Computed Coarse Mass Voltages (vdc)

LOX Empty	0.098	LH_2 Empty	0.000
LOX 1/3 Mass	1.421	LH_2 1/3 Mass	1.543
LOX 2/3 Mass	2.861	LH_2 2/3 Mass	3.184

Computed Fine Mass Voltages (vdc)

LOX Empty	3.911	LH_2 Empty	1.367
LOX 1/3 Mass	0.151	LH_2 1/3 Mass	2.241
LOX 2/3 Mass	1.919	LH_2 2/3 Mass	4.395

Computed Loading Voltages (vdc)

LOX Empty	0.547	LH_2 Empty	0.000
LOX 1/3 Coarse Mass	7.957	LH_2 1/3 Coarse Mass	8.641

PU System Power Test

Function	Measured Value	Limits
Forward Bus 2 Voltage (vdc)	26.68	28. ± 2
Inv-Conv 115 vrms Output (vac)	114.275	115. ± 3.4
Inv-Conv 21 vdc Output (vdc)	21.299	21.25 ± 1.25
Inv-Conv 5 vdc Output (vdc)	4.995	4.8 ± 0.3
Inv-Conv Frequency (Hz)	400.539	400. ± 6

4.1.18.1 (Continued)

Bridge Balance and PU System Ratio Valve Null Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1.265			0.000 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.107	0.103	0.098 ± 0.1
LOX Fine Mass Voltage (vdc)		3.989	3.989	3.911 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0.000	0.000	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.367	1.367	1.367 ± 0.4

PU Loading Test

Function	Measured Value	Limits
LH_2 Boiloff Bias Signal Volt (vdc)	8.18	7.400 ± 1.0
GSE Power Supply Voltage (vdc)	28.599	28.0 ± 2.0

Loading Potentiometer Function	LOX Value	LH_2 Value	Limits
Sense Voltage, GSE Power On (vdc)	28.438	29.399	GSE Pwr ± 0.4
Signal Voltage, Relay Commands	0.492		0.560 ± 0.5
Off (vdc)		-0.027	0.0 ± 0.5
Signal Voltage, 1/3 Checkout Relay	7.656		7.952 ± 2.0
Commands On (vdc)		8.504	8.652 ± 2.0
Signal Voltage, 1/3 Checkout Relay	0.492		0.560 ± 0.5
Commands Off (vdc)		0.000	0.0 ± 0.5
Sense Voltage, GSE Power Off (vdc)	0.000	-0.079	0.0 ± 0.75

Servo Balance Bridge Gain Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1.133			1.265 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.103	0.103	0.098 ± 0.1
LOX Fine Mass Voltage (vdc)		3.984	3.984	3.911 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0.000	-0.005	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.367	1.367	1.367 ± 0.4

1/3 Checkout Relay Commands On

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1.857			1.265 ± 1.5
LOX Coarse Mass Voltage (vdc)		1.416	1.416	1.421 ± 0.1
LOX Fine Mass Voltage (vdc)		0.088	0.088	0.151 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		1.553	1.543	1.543 ± 0.1
LH_2 Fine Mass Voltage (vdc)		2.358	2.363	2.241 ± 0.4

4.1.18.1 (Continued)

Function	Measured Value	AO Multi	BO Multi	Limits
2/3 Checkout Relay Commands On				
Ratio Valve Position (deg)	2.252			1.265 ± 1.5
LOX Coarse Mass Voltage (vdc)		2.856	2.871	2.861 ± 0.1
LOX Fine Mass Voltage (vdc)		1.694	1.704	1.919 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		3.188	3.188	3.184 ± 0.1
LH_2 Fine Mass Voltage (vdc)		4.633	4.633	4.395 ± 0.4
2/3 Checkout Relay Commands Off				
Ratio Valve Position (deg)	1.857			1.265 ± 1.5
LOX Coarse Mass Voltage (vdc)		1.421	1.416	1.421 ± 0.1
LOX Fine Mass Voltage (vdc)		0.093	0.093	0.151 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		1.538	1.548	1.543 ± 0.1
LH_2 Fine Mass Voltage (vdc)		2.354	2.358	2.241 ± 0.4
1/3 Checkout Relay Commands Off				
Ratio Valve Position (deg)	1.199			1.265 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.103	0.103	0.098 ± 0.1
LOX Fine Mass Voltage (vdc)		4.014	3.984	3.911 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0.000	-0.010	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.367	1.367	1.367 ± 0.4

PU Valve Movement Test

Function	Measured Value	Limits
Ratio Valve Position, AO (deg)	1.199	0.194 ± 1.50
Ratio Valve Position, BO (deg)	1.199	0.194 ± 1.50
50 Second Plus Valve Slew, AO Multiplexer		
+1 vdc System Test Valve Position Signal (vdc)	1.005	1.000 ± 0.036
V1, Position at T+3 Seconds (deg)	4.146	1.92 to 6.99
V2, Position at T+5 Seconds (deg)	5.197	2.51 to 6.99
V3, Position at T+8 Seconds (deg)	5.725	2.81 to 6.99
V4, Position at T+20 Seconds (deg)	5.987	4.94 to 6.99
V5, Position at T+50 Seconds (deg)	6.054	4.94 to 6.99

4.1.18.1 (Continued)

Function	Measured Value	Limits
50 Second Minus Valve Slew, AO Multiplexer		
Ratio Valve Position, AO (deg)	1.330	0.194 ± 1.50
-1 vdc System Test Valve Error Signal (vdc)	-1.010	-1.00 ± 0.036
V1, Position at T+3 Seconds (deg)	-3.814	-1.92 to -6.00
V2, Position at T+5 Seconds (deg	-4.801	-2.51 to -6.99
V3, Position at T+8 Seconds (deg)	-5.328	-2.81 to -6.99
V4, Position at T+20 Seconds (deg)	-5.591	-4.94 to -6.99
V5, Position at T+50 Seconds (deg)	-5.657	-4.94 to -6.99

PU Activation Test

Function	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	1.067	1.199	1.265 ± 1.5
LOX 1/3 Command Relay On			
LOX Coarse Mass Voltage (vdc)	1.416	1.411	1.421 ± 0.1
PU System On			
Ratio Valve Position (deg)	32.847	32.912	20.0 min
PU System Off			
Ratio Valve Position (deg)	1.594	1.660	15.0 max
LOX 1/3 Command Relay Off			
LOX Coarse Mass Voltage (vdc)	0.103	0.103	0.098 ± 0.1
Ratio Valve Position (deg)	1.199	1.265	1.265 ± 1.5
LH_2 1/3 Command Relay On			
LH_2 Coarse Mass Voltage (vdc)	1.548	1.548	1.543 ± 0.1
PU System On			
Ratio Valve Position (deg)	-25.250	-25.118	-20.0 max
PU System Off			
Ratio Valve Position (deg)	1.330	1.400	-15.0 min

4.1.18.1 (Continued)

Function	AO Multi	BO Multi	Limits
LH_2 1/3 Command Relay Off			
Static Inv Conv 5 vdc Output (vdc)	4.982	4.979	4.8 ± 0.3
LH_2 Coarse Mass Voltage (vdc)	0.000	0.005	0.000 ± 0.1
Ratio Valve Position (deg)	1.199	1.199	1.265 ± 1.5
PU Valve Hardover Test			
LH_2 1/3 Command Relay On			
Ratio Valve Position, AO (deg)	-25.2		-20.0 max

4.1.19 Exploding Bridgewire System (1B55822 D)

This automatic procedure verified the design integrity of the exploding bridgewire (EBW) system, and demonstrated the operational capability of the EBW system to initiate ullage rocket ignition and jettison when commanded by the instrument unit during flight. The particular items involved in this test were:

	Part Name	Ref. Location	P/N	S/N
	Ullage Rocket Ignition System			
	EBW Firing Unit	404A47A1	40M39515-113	285
	EBW Firing Unit	404A47A2	40M39515-113	282
	Pulse Sensor *	404A47A4A2	40M02852	-
	Pulse Sensor *	404A47A4A2	40M02852	-
*	On Pulse Sensor Bracket Assy	404A47A4	1B52640-1	1
	Ullage Rocket Jettison System			
	EBW Firing Unit	404A75A1	40M39515-113	277
	EBW Firing Unit	404A75A2	40M39515-113	283
	Pulse Sensor **	404A75A10A1	40M02852	-
	Pulse Sensor **	404A75A10A2	40M02852	-
**	On Pulse Sensor Bracket Assy	404A75A10	1A97791-501	3

This procedure was accomplished on 16 September 1967, and was accepted on 18 September 1967. Throughout this procedure, the charged condition of each EBW firing unit was determined by verifying that the firing unit voltage indication measured 4.2 ± 0.3 vdc, while the uncharged or discharged condition was determined by verifying that the voltage indication measured 0.0 ± 0.3 vdc, or during the firing unit disable test, 0.2 ± 0.3 vdc.

The stage power setup, H&CO 1B55813, was accomplished and initial conditions were established. An EBW pulse sensor self test was conducted first, by verifying that the self test command properly turned on the four EBW pulse

4.1.19 (Continued)

sensors, and that the reset command properly turned off the pulse sensors.

The ullage ignition EBW firing units were tested next. The charge ullage ignition command was verified to properly charge both ullage ignition EBW firing units, while both ullage jettison EBW firing units remained uncharged. To verify that the fire ullage ignition command properly fired the ullage ignition EBW firing units, it was determined that both ignition pulse sensors were turned on while both jettison pulse sensors remained off, and that both ullage ignition EBW firing units were discharged.

The ullage jettison EBW firing units were tested in the same way; by verifying that the charge ullage jettison command charged the ullage jettison EBW firing units, and that the fire ullage jettison command fired the jettison firing units and turned on the jettison pulse sensors.

A series of checks then verified that the EBW ullage rocket firing unit disable command prevented the firing units from charging, when the charge ullage ignition and charge ullage jettison commands were turned on; and discharged the firing units, while preventing them from firing when the fire ullage ignition and fire ullage jettison commands were turned on.

A final series of checks verified the operation of the EBW pilot relay by determining that the pilot relay reset indication was off after each of the charge ullage ignition and jettison, and fire ullage ignition and jettison commands were turned on, and that the pilot relay reset indication was on

4.1.19 (Continued)

after each command was reset. The switch selector was used 22 times during this procedure, and each of the ignition and jettison firing units were discharged 3 times.

Engineering comments noted that all parts were installed at the start of this checkout. No problems were encountered during this test, and no FARR's were written. One revision was made to the procedure to correct an error in the program.

4.1.20 Range Safety System (1B55821 F)

The automatic checkout of the range safety system verified the system external/internal power transfer capability; and the capability of the system to respond to the propellant dispersion inhibit and trigger commands, the engine cutoff command, and the system off command. The items involved in this test included the following:

Part Name	Reference Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	172
Range Safety Receiver 2	411A97A18	50M10697	166
Secure Command Decoder 1	411A99A1	50M10698	019
Secure Command Decoder 2	411A99A2	50M10698	091
Secure Command Controller 1	411A97A13	1B33084-503	014
Secure Command Controller 2	411A97A19	1B33084-503	013
RS System 1 EBW Firing Unit	411A99A12	40M39515-119	451
RS System 2 EBW Firing Unit	411A99A20	40M39515-119	450
RS System 1 EBW Pulse Sensor	411A99A31*	40M02852	295
RS System 2 EBW Pulse Sensor	411A99A32*	40M02852	249
Safe and Arm Device	411A99A22*	1A02446-503	00020
Directional Power Divider	411A97A56	1B38999-1	033
Hybrid Power Divider	411A97A34	1A74778-501	041
* Installed in Pulse Sensor Assembly	411A99A31/A32	1B29054-501	00006

This procedure was satisfactorily accomplished by the first attempt on 20 September 1967, and was accepted on the same date. Values measured during the test are shown in Test Data Table 4.1.20.1. Initial conditions were established for the test, and the GSE destruct system test set, P/N 1A59952-1, was set up for closed loop operation at 450 MHz with a -50 dbm output level and a 60 kHz deviation. The forward bus 1 and bus 2 battery simulators were turned on, both receivers were verified to be off, and the battery simulator voltages were measured.

4.1.20 (Continued)

The external/internal power transfer test was then started. Both EBW firing units were verified to be off, and external power was turned on for both receivers and both firing units. The firing unit charging voltage indications and the firing unit indications were measured for both range safety systems. The propellant dispersion cutoff command inhibit was then turned on for both receivers. Both firing units were transferred to internal power, and the external power for the units was turned off. Both units were verified to be on, and the charging voltage indications were measured. Both firing units were transferred back to external power and verified to be off, and the firing unit charging voltage indications were again measured. The external power for both receivers was turned off, and the receivers were verified to be off. The receivers were transferred to internal power and verified to be on, then transferred back to external power and verified to be off. Finally, both receivers were transferred back to internal power and again verified to be on.

The EBW firing unit arm and engine cutoff test was conducted next. The engine control bus power was turned on, the bus voltage was measured, and the low level signal strength indications were measured for both receivers. The EBW firing unit arm and engine cutoff command was turned on and verified to be received by range safety system 1. The system 1 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were off at the umbilical and through the AO and BO telemetry multiplexers; that the nonprogrammed engine cutoff indication was off; and that the instrument unit receiver 1 arm and engine cutoff indication was off. The receiver 1 propellant dispersion cutoff command inhibit was then turned off, and the instrument unit receiver 2 arm and engine cutoff indication was

4.1.20 (Continued)

verified to be off. Verification was made that the engine control bus power was then off; that the engine cutoff indications were still off at the umbilical and through both multiplexers; that the nonprogrammed engine cutoff indication was still off; and that the instrument unit receiver 1 arm and engine cutoff indication was then on. The receiver 1 propellant dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 1 arm and engine cutoff indication was verified to again be off. The EBW firing unit arm and engine cutoff command was turned off. The engine control bus power was turned back on, and the bus voltage was measured. Both firing units were transferred to external power and verified to be off, and the charging voltage indications were measured.

The EBW firing unit arm and engine cutoff command was turned back on and verified to be received by range safety system 2. The system 2 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were off at the umbilical and through the AO and BO telemetry multiplexers; that the nonprogrammed engine cutoff indication was off; and that the instrument unit receiver 2 arm and engine cutoff indication was off. The receiver 2 propellant dispersion cutoff command inhibit was turned off, and the instrument unit receiver 1 arm and engine cutoff indication was verified to be off. Verification was made that the engine control bus power was still on; that the engine cutoff indication was then on at the umbilical and through both multiplexers; that the nonprogrammed engine cutoff indication was then on; and that the instrument unit receiver 2 arm and engine cutoff indication was on. The receiver 2 propellant

4.1.20 (Continued)

dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 2 arm and engine cutoff indication was verified to again be off. The EBW firing unit arm and engine cutoff command was turned off. The engine ready bypass was turned on, and the engine cutoff indication was verified to be off at the umbilical.

The EBW pulse sensor power and pulse sensor self-test were turned on, and both range safety pulse sensors were verified to be set. The pulse sensor reset was turned on, and both pulse sensors were verified to be reset. Each of the range safety systems was individually tested by the following steps, starting with system 1. The propellant dispersion command was turned on and verified to be received by the receiver under test. The appropriate firing unit charging voltage indication was measured, and the appropriate pulse sensor was verified to be off. The propellant dispersion command was turned off, the propellant dispersion cutoff command inhibit for the receiver under test was turned off, and the propellant dispersion command was turned back on. For the system under test, the firing unit charging voltage indication was measured, and the pulse sensor was verified to be on. The propellant dispersion cutoff command inhibit was then turned back on, and the propellant dispersion command was turned off. The above steps were then repeated to test system 2. After the test of system 2, the propellant dispersion cutoff command inhibit was turned off for both receivers, and the engine control bus power was verified to be off.

4.1.20 (Continued)

The range safety system off test was conducted next. The range safety system off command was turned on, and power for receiver 1 and the system 1 EBW firing unit was verified to be off. The range safety system off command was turned off, receiver 2 was transferred to internal power, the range safety system off command was turned back on, and the power for receiver 2 and the system 2 EBW firing unit was verified to be off. The range safety system off command was then turned back off.

The safe and arm device was tested next. The safe-arm safe command was turned on, the safe indication was verified to be on, and the arm indication was verified to be off. The safe-arm arm command was turned on, the safe indication was verified to be off, and the arm indication was verified to be on. The safe-arm safe command was turned back on, and again the safe indication was verified to be on, and the arm indication was verified to be off.

This completed the range safety system tests, and the shutdown operations were accomplished. The computer printout indicated that each of the two range safety receivers and two secure decoders had accumulated 2 minutes 0.958 seconds of running time during the procedure, each of the range safety EBW firing units had been cycled 1 time, and the switch selector had been used 1 time.

Engineering comments noted that there were no part shortages affecting this test. No problems were encountered during the test, and no FARR's were written. Two revisions were made to the procedure for the following:

4.1.20 (Continued)

a. One revision explained that a SIM interrupt on channel 141 was expected.

b. One revision deleted a step no longer required.

4.1.20.1 Test Data Table, Range Safety System

Function	Measured Value (vdc)	Limits (vdc)
Forward Bus 1 Battery Simulator	28.239	28.0 ± 2.0
Forward Bus 2 Battery Simulator	29.399	29.0 ± 2.0
External/Internal Power Transfer Test		
External Power On		
System 1 Charging Voltage Indication	4.169	4.2 ± 0.3
System 1 Firing Unit Indication	4.169	4.2 ± 0.3
System 2 Charging Voltage Indication	4.278	4.2 ± 0.3
System 2 Firing Unit Indication	4.276	4.2 ± 0.3
Internal Power		
System 1 Charging Voltage Indication	4.164	4.2 ± 0.3
System 2 Charging Voltage Indication	4.284	4.2 ± 0.3
External Power Off		
System 1 Charging Voltage Indication	0.034	0.3 max
System 2 Charging Voltage Indication	0.045	0.3 max
Firing Unit Arm and Engine Cutoff Test		
Engine Control Bus Voltage	27.999	28.0 ± 2.0
Receiver 1 Signal Strength Indication	3.472	3.75 ± 1.25
Receiver 2 Signal Strength Indication	3.712	3.75 ± 1.25
System 1 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.169	4.2 ± 0.3
Engine Control Bus Voltage	28.000	28.0 ± 2.0
External Power Off		
System 1 Charging Voltage Indication	0.045	0.3 max
System 2 Charging Voltage Indication	0.050	0.3 max

4.1.20.1 (Continued)

Function	Measured Values (vdc)	Limits (vdc)
System 2 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.279	4.2 ± 0.3
Propellant Dispersion Test		
System 1 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4.185	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On)	1.585	3.0 max
System 2 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4.294	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On)	1.574	3.0 max

4.1.21 Propulsion System Check (1B62753 F)

Initiated on 20 September 1967, completed on 26 September 1967, and accepted on 27 September 1967, this automatic checkout defined and provided the electromechanical functional tests required to certify the operational capability of the stage propulsion system. For convenience of performance, the test sequences were divided into three sections: the first section checked the pump purge pressure switches for activation, deactivation, and proper control function, and ensured the functional capability and valve operation of the pneumatic control system and the propellant tanks repressurization systems; the second section verified the operation of the propellant tank pressurization systems; and the third section was a four-part check of the J-2 engine spark ignition system cutoff logic and delay timers, engine control helium bottle and valves, and engine operating sequence.

The stage functions, dependent upon the ambient helium system, were the pneumatic control system and the propellant tanks repressurization systems. For a helium transducer check, it was verified that the initial helium sphere pressure was 700 $\pm$50 psia, and that the helium regulator discharge pressure was 515 $\pm$50 psia, as measured through the multiplexers. The control helium dump valve and control module shutoff valve were functionally checked to begin the system test. This was followed by functional tests of the LOX chilldown pump purge pressure switch and the propellant tanks repressurization control modules.

The LOX and LH_2 tank, the flight control pressure switch, the O_2H_2 burner spark system, the O_2H_2 burner voting circuits, and the repressurization

4.1.21 (Continued)

interlock checks followed. The engine pump purge pressure switch and the control helium regulator pressure switch pickup and dropout pressures were measured. A series of checks verified the proper operation of the various pneumatically controlled valves. The operating times for the valves functioned are shown in the Test Data Table. The O_2H_2 burner spark system, the LH_2 continuous vent valve, the LH_2 tank pressurization, the O_2H_2 burner valve, and the LOX shutdown valve tests were rerun due to the installation of new hardware on the stage. A switch selector control check of the valves completed this section of the procedure.

Section 2, the LOX and LH_2 repressurization check was accomplished next. The cold helium dump valve and shutoff valve were verified to operate properly. The operation of the cold helium regulator backup pressure switch was verified by making measurements three times, as shown in the Test Data Table, and by verifying that the switch properly controlled the cold helium shutoff valve. The LOX and LH_2 repressurization control valves were verified to operate properly, and the operation of the LOX and LH_2 tank repressurization backup pressure switch interlocks was verified by making measurements three times, as shown in the Test Data Table, and by verifying that the switches properly controlled the LOX and LH_2 repressurization control valves.

The proper operation of the O_2H_2 burner spark ignition system was then verified. The LOX tank pressure switches, the cold helium shutoff valve, and the cold helium heat exchanger bypass valve were all verified to operate properly, with measurements made three times on the LOX tank ground fill pressure switch, as shown in the Test Data Table. The proper operation of the cold helium

4.1.21 (Continued)

regulator was then verified by determining that the regulator output pressure dropped from 411.11 psia to 414.47 psia, well above the 375. psia minimum limit, while the cold helium spheres pressure dropped from 842.98 psia to 617.67 psia with test orifice SO772C12-197 installed in the test adapter.

The proper operation of the LH_2 tank pressurization system step pressure valve and bypass control valve was verified; the LH_2 flight control and ground fill pressure switches were verified to operate properly by measurements made three times, as shown in the Test Data Table; and the proper control of the step pressure valve and repressurization control valve by the pressure switches was verified. The cold helium spheres were then vented and a final series of checks verified the proper operation of the O_2H_2 burner voting circuit, temperature sensors, and repressurization control valves with the cold helium spheres at ambient pressure.

Section 3, the J-2 engine system test, was divided into four sequences, each designed to test a specific engine operation. The spark ignition system check was first, followed by the mainstage OK pressure switch test. The control solenoid valves check was then conducted, after which the engine sequence check was run.

The LH_2 and LOX vent valves were opened to vent the propellant tanks to ambient pressure. The O_2H_2 burner spark systems 1 and 2, the emergency detection systems 1 and 2 engine cutoffs, the repressurization control valves, and the O_2H_2 burner propellant valves were all verified to operate properly. The LH_2 and LOX prevalves and chilldown shutoff valves were then closed. A series of checks then verified that the engine spark ignition systems, 1 and 2, properly caused thrust chamber and gas generator sparks.

The engine start tank was pressurized, the proper operation of the start tank vent valve was verified, and the start tank was vented back to ambient pressure. For an engine cutoff test the engine ready signal was verified to be on, it was verified that the simulated mainstage OK signal opened the LH_2 and LOX prevalves, that the switch selector engine cutoff signal operated properly and closed the prevalves, and that removing the cutoff signal reopened the prevalves. The proper operation of the switch selector engine start and LH_2 injector temperature detector bypass commands was verified, and the engine ignition timer was measured, as shown in the Test Data Table.

The next series of checks verified that the aft separation simulation 1 and 2 signals individually inhibited the engine start, and then verified the proper operation of the LH_2 injector temperature detector bypass, the start tank discharge control indication, the ignition detected indication, and the helium control solenoid valve. During these checks, measurements were made of the helium delay timer, the sparks de-energized timer, and the start tank discharge timer, as shown in the Test Data Table.

A series of checks next verified the proper operation of the mainstage OK pressure switches 1 and 2, with measurements made three times as shown in the Test Data Table, and verified that the pickup of either switch turned off the engine thrust OK 1 and 2 indications, and that, after a dry engine start sequence, the pick up of either switch would maintain the engine in

4.1.21 (Continued)

mainstage. It was also verified that the dropout of both pressure switches turned on the engine thrust OK indications and caused engine cutoff.

The helium control sphere was pressurized to 1402.94 psia, meeting the 1400 $\pm$50 psia limit, for the engine solenoid valve component checks. A series of checks then verified that opening and closing the helium control solenoid valve caused the LH_2 and LOX bleed valves to close and open; that opening and closing the ignition phase control solenoid valve caused the engine augmented spark ignitor (ASI) LOX valve and the engine main LH_2 valve to open and close; that the start tank discharge solenoid valve opened and closed properly; and that opening and closing the mainstage control solenoid valve caused the gas generator valve and main LOX valve to open and close, and the LOX turbine bypass valve to close and open. During these checks, valve position measurements were made, as shown in the Test Data Table, and the engine regulator outlet pressure was measured as 419.17 psia through both multiplexers, when the helium control solenoid valve was opened.

For the final engine sequence check, the entire engine system was verified to be ready for the check, and a completely automatic repetition of the previous engine system checks was accomplished by giving the necessary commands to cause engine start and cutoff. Throughout the automatic sequence, the system responses were verified to be within predetermined limits. Various operating times were measured during the sequence, as shown in the Test Data Table, to verify the proper operation of the system component items. Also, the engine regulator outlet pressure was measured as 419.94 psia at the time of engine

4.1.21 (Continued)

start. Engineering comments indicated that all parts were installed at the start of this test. No FARR's were written against the stage as a result of this test.

Forty-six revisions were made to the procedure for the following:

a. Twenty-three revisions deleted or added requirements to correct program errors or update the procedure.

b. Eighteen revisions explained malfunction printouts that were the result of program errors.

c. Three revisions reran sections of the checkout to obtain engineering information.

d. Two revisions placed the stage in flight configuration for test purposes.

4.1.21.1 Test Data Table, Propulsion System Test

Section 1, Ambient Helium Test

Function	Measured Value Test 1	Test 2	Test 3	Limits
Pressure Switch Checks				
LOX Childown Pump Purge Pressure Switch				
Pump Purge PS Pickup (psia)	40.27	40.33	40.27	*
Pump Purge PS Dropout (psia)	39.02	39.02	38.97	*
Pump Purge PS Deadband (psia)	1.25	1.30	1.30	*
Repress System Interlocks				
LOX Repress Hz Sphere Press, D088, (psia)	637.53			*
Burner Spark No. 1 ON OK (vdc)	3.51			2.7 min
Burner Spark No. 2 ON OK (vdc)	3.67			2.7 min

* Limits Not Specified

4.1.21.1 (Continued)

Function	Measured Value Test 1	Test 2	Test 3	Limits
Engine Pump Purge Pressure Switch				
Pump Purge PS Pickup (psia)	112.13	111.34	111.34	*
Pump Purge PS Dropout (psia)	102.62	102.62	102.62	*
Pump Purge PS Deadband (psia)	9.51	8.71	8.71	*
Control Helium Regulator Backup Pressure Switch				
He Reg. Backup Press Time (sec)	87.217	39.442	39.395	*
He Reg. Backup Depress Time (sec)	11.644	11.384	11.393	*
He Reg. Backup PS Dropout (psia)	480.60	480.60	480.60	*
He Reg. Backup PS Pickup (psia)	590.23	587.08	587.08	*

Pneumatically Controlled Valve Test

Valve	Operating Times (sec) Open	Total Open	Close	Total Close	Boost Close	Total Boost
LH_2 Vent Valve	0.017	0.079	0.201	0.460	0.078	0.240
LOX Vent Valve	0.021	0.066	0.113	0.340	0.064	0.211
LOX Fill and Drain Valve	0.148	0.264	0.715	2.136	0.428	0.925
LH_2 Fill and Drain Valve	0.156	0.284	0.788	2.333	0.408	0.890
LOX Prevalve	1.548	2.301	0.263	0.403	-	-
LOX Chilldown Shutoff	0.252	1.098	0.222	0.127	-	-
LH_2 Chilldown Shutoff	0.221	1.069	0.007	0.135	-	-
LH_2 Prevalve	1.448	2.172	0.259	0.415	-	-
LH_2 Continuous Vent Orifice Bypass Valve	0.007	0.127	0.007	0.141	-	-
Burner LH_2 Propellant Valve	0.034	0.122	0.063	0.209	-	-
Burner LOX Propellant Valve	0.060	0.174	0.055	0.148	-	-
Burner LOX Shutdown Valve	0.007	0.081	0.008	0.178	-	-

	Position Flight	Total Flight	Ground	Total Ground
LH_2 Directional Vent Valve	0.066	0.153	0.804	1.350

* Limits Not Specified

4.1.21.1 (Continued)

Section 2, Pressurization System Check

Function	Measured Value Test 1	Test 2	Test 3	Limits
Pressure Switch Checks				
Cold Helium Regulator Backup Pressure Switch				
Pressurization Time (sec)	67.410	27.217	27.263	180.0 max
Pickup Pressure (psia)	453.77	451.40	451.40	467.5 + 23.5
Depressurization Time (sec)	17.152	16.978	16.932	180.0 max
Dropout Pressure (psia)	355.04	355.04	355.04	362 ± 33.5
LOX Tank Repressurization Backup Pressure Switch				
Pressurization Time (sec)	29.329	49.414	49.728	180.0 max
Pickup Pressure (psia)	451.40	449.03	449.82	467.5 + 23.5
Depressurization Time (sec)	14.564	14.50	14.378	180.0 max
Dropout Pressure (psia)	367.68	365.31	366.89	362.5 ± 33.5
LH_2 Tank Repressurization Backup Pressure Switch				
Pressurization Time (sec)	55.411	55.099	54.753	180.0 max
Pickup Pressure (psia)	465.61	464.03	466.40	467.5 + 23.5
Depressurization Time (sec)	16.817	16.827	16.812	180.0 max
Dropout Pressure (psia)	365.31	363.73	363.73	362.5 ± 33.5
LOX Tank Ground Fill Pressure Switch				
Manifold Press Time (sec)	32.751	20.893	16.182	180.0 max
Pickup Pressure (psia)	40.38	40.38	40.38	41.0 max
Depressurization Time (sec)	3.754	3.552	3.508	180.0 max
Dropout Pressure (psia)	39.02	38.97	38.92	37.5 min
Deadband (psia)	1.36	1.41	1.46	0.5 min
LH_2 Flight Control and Ground Fill Pressure Switches				
Manifold Press Time (sec)	149.587	114.082	150.608	180.0 max
Manifold Depress Time (sec)	170.450	173.612	171.951	180.0 max
Flight Control Pickup (psia)	30.65	30.65	30.75	31.5 max
Flight Control Dropout (psia)	28.03	27.98	28.03	27.8 min
Flight Control Deadband (psi)	2.62	2.67	2.72	0.5 min
Ground Fill Pickup (psia)	33.53	33.58	33.58	34.0 max
Ground Fill Dropout (psia)	31.12	31.12	31.17	30.8 min
Ground Fill Deadband (psi)	2.41	2.46	2.41	0.5 min

4.1.21.1 (Continued)

Pressure Switch Checks

Function	Measured Value Test 1	Test 2	Test 3	Limits
Burner Spark System Checks				
Exciter No. 1 Off (Umb)(vdc)	0.02	-	-	2.0 max
Exciter No. 2 Off (Umb)(vdc)	0.00	-	-	2.0 max
Exciter No. 1 On OK (Umb)(vdc)	3.66	-	-	2.7 min
Exciter No. 2 On OK (Umb)(vdc)	3.72	-	-	2.7 min
Exciter No. 1 Ind On T/M M0074 (vdc)	3.63	-	-	2.7 min
Exciter No. 2 Ind On T/M M0073 (vdc)	3.63	-	-	2.7 min
Exciter No. 1 Off to T/M M0074 (vdc)	0.00	-	-	0.0 ± 0.2
Exciter No. 2 Off to T/M M0073 (vdc)	0.00	-	-	0.0 ± 0.2

Section 3, J-2 Engine Checks

Engine Timer Checks

Function	Delay Time (sec)	Limits (sec)
Engine Ignition Timer	0.432	0.450 + 0.030
Helium Delay Timer	0.987	1.000 ± 0.110
Sparks De-Energized Timer	3.326	3.300 ± 0.200
Start Tank Discharge Timer	1.007	1.000 ± 0.040

Pressure Switch Checks

Function	Measured Value Test 1	Test 2	Test 3	Limits
Mainstage OK Pressure Switch 1				
Pickup Pressure (psia)	540.20	539.43	541.42	515.0 + 36.0
Gropout Pressure (psia)	503.57	505.13	504.35	PU-62.5 ± 43.5
Deadband Pressure (psia)	36.63	34.30	37.07	
Mainstage OK Pressure Switch 2				
Pickup Pressure (psia)	504.27	505.07	503.48	515.0 + 36.0
Dropout Pressure (psia)	437.19	441.13	439.55	PU-62.5 ± 43.5
Deadband Pressure (psia)	67.08	63.94	63.93	

4.1.21.1 (Continued)

Engine Sequence Check

Function	Start Time (sec)	Oper. Time (sec)	Total Time (sec)
Engine Start			
Ignition Phase Solenoid Command Talkback	-	0.006	-
Control Helium Solenoid Command Talkback	-	0.012	-
ASI LOX Valve Open	-	0.044	-
Main LH Valve Open	0.049	0.076	0.125
LOX Bleed Valve Closed	-	0.084	-
LH2 Bleed Valve Closed	-	0.061	-
Start Tank Discharge Timer	-	1.005	-
Start Tank Discharge Valve Open	0.091	0.114	0.205
Mainstage Control Solenoid Energize	-	1.456	-
Ignition Phase Timer	-	0.451	-
Start Tank Discharge Control Solenoid Off	-	0.006	-
Main LOX Valve Open	0.517	1.734	2.251
Gas Generator Valve LOX Poppet Open	0.095	0.142	0.236
Start Tank Discharge Valve Closed	0.169	0.141	0.310
LOX Turbine Bypass Valve Closed'	0.262	0.249	0.511
Spark System Off Timer	-	3.339	-
Engine Cutoff			
Ignition Phase Control Solenoid Off	-	0.007	-
Mainstage Control Solenoid Off	-	0.015	-
ASI LOX Valve Closed	0.036	-	-
Main LOX Valve Closed	0.067	0.161	0.228
Main LH2 Valve Closed	0.095	0.177	0.271
Gas Generator Valve Closed	0.095	0.142	0.236
LOX Turbine Bypass Valve Open	0.505	0.264	0.769
Helium Control Solenoid De-energize Timer	-	0.990	-
LOX Bleed Valve Open	8.442	-	-
LH2 Bleed Valve Open	8.167	-	-

4.1.22 Digital Data Acquisition System (1B55817 F)

This procedure provided the manual and automatic operations for the checkout and calibration of the digital data acquisition system (DDAS), to prepare the system for further testing operations including static firing of the stage. The proper functioning of the DDAS was verified from data inputs, through the various multiplexers and the PCM/DDAS assembly to the DDAS ground station. The remote automatic calibration (RACS) was also tested.

All channels having signal insertion capabilities were compared, one at a time, to their tolerance limits by the computer through RACS. Channels without RACS capabilities were tested by comparing their end item outputs at ambient conditions. Ambient conditions are defined as 70°F at 14.7 psi, and for bi-level parameters, the normal state of valves or switches during the performance of the test.

The particular components involved in this test were the PCM/DDAS assembly, P/N 1A74049 511, S/N 016; the time division multiplexers, P/N 1B62513-547, S/N 013; and P/N 1B62513-543, S/N 014; the remote digital submultiplexer (RDSM), P/N 1B52894-501, S/N 025; the low level remote analog submultiplexer (RASM), P/N 1B54062-503, S/N 040; and the PCM RF assembly, P/N 1B52721-521, S/N 34.

The checkout was initiated on 25 September 1967, and was completed and accepted on 27 September 1967, after 2 days of activity. Initial conditions were established, and the DDAS ground station was calibrated to verify that the ground station and peripheral equipment were properly setup and ready for test. The RF group power was turned on and after a warmup period of 180 seconds, the

4.1.22 (Continued)

output of the transmitter was measured at 29.713 watts for the forward power (FP) and at 12.723 watts for the reflected power (RP). The standing wave ratio was calculated to be 4.786:1, resulting in a malfunction printout by the computer. Tolerance limits were stated as 3.0 ± 1 maximum. This malfunction was documented on FARR A261634. The test was continued and it was verified that the DDAS ground station was in synchronization with the stage DDAS. The RF distribution system and the RF group power were turned on, and the DDAS ground station was again verified to be in synchronization with the stage DDAS. The DDAS input was turned on, and the DDAS ground station was again verified to be in synchronization with the stage DDAS. The RF group power test was then terminated.

The engine control bus power was turned on, and the ambient temperature, 66°F, was loaded into the computer program. All CP1-B0 and DP1-B0 multiplexers were functionally checked. During the DP1-B0 multiplexer test, the following parameters indicated out-of-tolerance readings: C395 and C397, the transducers were not installed at the time of test; D050, the pressure at the time of sampling was not at ambient; D223, the hydraulic pump air tank was not pressurized at the time of test; D181, the reason for this malfunction could not be verified (ref. FARR A261630). All channels that indicated malfunctions, with the exception of D181, were later verified to be operating within specified limits.

The CP1-B0 and DP1-B0 multiplexers for the APS modules were checked next; then, the common bulkhead pressure was measured and entered into the computer program and verified to be within tolerance.

4.1.22 (Continued)

Two transducers, P/N's 1B51689-503, for parameters C395 and C397, were short at the time of this test. These transducers were replaced during the postfire checkout. One IUM part, a transducer, P/N 1A72913-517, for parameter D576, was installed in place of the flight transducer. Two FARR's were written as a result of this checkout for the following:

a. FARR A261630 documented an out-of-tolerance condition, due to excessive noise, for parameter D181. This condition was to be investigated during postfire checkout.

b. FARR A261634 documented an out-of-tolerance VSWR reading due to test stand conditions; however, the actual cause was a loose plug on cable assembly, P/N 1B58316-1, 411W207P2. The defective cable assembly was removed and replaced. Recalculation of the VSWR indicated 1.312:1, well within tolerance limits.

There were thirteen revisions made to the procedure for the following:

a. Two revisions added or changed the procedure for requirements that were missing or in error.

b. Four revisions added information to the computer program.

c. Five revisions explained malfunction printouts.

d. One revision reran previously run sections of the procedure after the replacement of a defective cable assembly.

e. One revision was voided.

4.1.23 Integrated System Test (1B55831 E)

This automatic checkout verified the design integrity and operation capability of the S-IVB stage and facility systems which were functional during propellant loading and static acceptance firing.

The automatic and manual test sequences performed during this checkout were initiated on 27 September 1967.

The stage power setup procedure established initial conditions and systematically applied power to the stage buses and systems required for operation of the test.

The GSE valve functional checkout established an ambient condition in the pneumatic console by bleeding down all regulators and resetting them to predetermined values. All console and sled valves used in propellant loading and static acceptance firing were cycled, and the heat exchanger was functionally checked. There were two malfunctions that indicated the stage 1 GH_2 bleed valve did not open and that the LH_2 sled supply pressure was out-of-tolerance at 53.190 psia. The GH_2 bleed valve did not malfunction, the program was in error at this point as the line pressure was not high enough to require venting. The out-of-tolerance condition of the LH_2 sled supply was due to a pressure lockup in the LH_2 system. After venting the LH_2 system, the test continued.

The telemetry and digital data acquisition systems were checked next, with the PCM transmitter operated open loop during this section. The telemetry 5 step calibration high and low RACS, and special calibrations of flows, speed,

4.1.23 (Continued)

and frequencies were commanded to provide verification of all calibration techniques. The parameters on the CP1-BO and DP1-BO multiplexers and remote analog and digital submultiplexers, which were required for loading or firing, were verified by receipt of the proper response through open loop PCM transmissions. There were three channel malfunctions associated with this section, one was attributed to the transducer RF sensitivity, and two were attributed to program errors. During the CP1-BO multiplexer test, thirty-seven functions were verified to be off and twenty functions were verified to be on. The DP1-BO multiplexer test verified seven functions to be off and thirteen functions to be on.

The torch and water test was performed satisfactorily. Following setup of the console GH_2 supply, the GH_2 igniters, diffuser water, deflection plate water, and aspirator water were functioned in sequence. This series of events verified that proper water pressures and torch ignition signals were received.

During the stage valves and O_2H_2 burner functional checkouts, the LH_2 and LOX vent valves and the fill and drain valves were opened and closed while the valve operating times were measured. Then the LOX and LH_2 valves were opened and boosted closed and the boost close times were measured. The LOX and LH_2 prevalves and chilldown shutoff valves were closed and opened while the operating times were measured. The LH_2 directional vent valve was set to the flight and ground positions while the operating times were measured; then the simulated O_2H_2 burner firing flight sequence was conducted. One malfunction was

4.1.23 (Continued)

recorded during the test, a safety item monitor interrupt (SIM) on channel 41. This SIM interrupt was caused by an operating error.

Engine gimbal testing followed the stage valve functional test. The auxiliary hydraulic system was operated while verifying the proper pressures and levels prior to and after restrainer link disengagement. The J-2 engine received a step gimbal signal, as well as 1/4 and 1/2 degree sinusoidal inputs of 6.0, 5.0, and 7.0 Hz. The checkout proceeded without interruption.

A final dry sequence of the J-2 engine, through the use of simulation commands for ASI ignition and mainstage ignition, was conducted to verify proper engine operation as well as the ESCS spark monitoring circuitry. A second run of this section was required due to a defective galvanometer in the GIS engine oscillograph during the first run. After the GIS equipment repair, the second run was completed satisfactorily.

The ullage rocket ignition and jettison EBW units were functionally certified by charging and firing into the pulse sensors.

The overfill point level sensors and depletion point level sensors were proven to operate satisfactorily by cycling the sled main fill and replenish valves with 2-out-of-3 depletion sensors verifying the cutoff logic operations. In addition, the individual ability to create a cutoff was proven for the engine lockout component test power and engine lockout GSE power.

The propellant utilization system test verified that the inverter-converter outputs were correct and cycled the PU mass bridge, which created positive and negative error signals for verification of the engine PU valve position.

4.1.23 (Continued)

The stage bus internal power was setup by the use of secondary battery power. The forward internal/external cycle was completed by switching normal telemetry current to forward bus 1 and PU current to forward bus 2. Following the APS and range safety functional checks, the aft bus 1 was cycled from internal to external with stage ambient and APS currents at ambient. The LOX and LH_2 chilldown inverters were operated for current and frequency tests; then, aft bus 2 was switched from internal to external. This completed stage testing for the integrated system test.

Engineering status review indicated that all parts were installed at the start of this test, and the procedure was accepted on 29 September 1967.

There were thirty-one revisions made to the procedure for the following:

a. Twenty-one revisions concerned corrections of the procedure, TRD, and program errors.

b. One revision explained a malfunction statement that the GH_2 bleed valve was not open. This statement was misleading. Residual pressure, at 70.21 psig, was trapped during leak checks, and the automatic program was looking for less than 70 psig.

c. One revision explained the malfunction statement, "LH_2 SLED SUPPLY PRESSURE OUT-OF-TOLERANCE". This was caused by residual pressure lock up in the LH_2 supply system. The pressure was 53.190 psia and the automatic program looked for less than 20 psia. After venting, the pressure was within tolerance.

d. One revision stated that the reason for the malfunction indication on D016 was due to the transducer RF sensitivity.

e. Two revisions were concerned with the malfunctions on D014 and D050. The system pressure for these two parameters decayed very slowly when vented. The program checks the system pressure immediately after start of venting. At that time the system was still pressurized.

f. One revision explained that the SIM interrupt on channel 41 was due to an operator's error.

4.1.23 (Continued)

g. Four revisions explained that the rerun of the J-2 engine sequence was due to failure of an oscillograph to record data.

4.1.23.1 Test Data Table, Integrated System Test

CP1-BO Multiplexer Ambient Measurements and High and Low RACS Voltages

Meas. No	Function	Measurement	Limits
D043	Amb Output	2353.750 psia	2350.000 + 125.000 psia
M025	Hi RACS Test	3.994 vdc	4.000 ∓ 0.050 vdc
M025	Lo RACS Test	-0.005 vdc	0.000 ∓ 0.050 vdc
M025	Amb Output	4.997 vdc	5.000 ∓ 0.030 vdc
D236	Hi RACS Test	4.015 vdc	4.000 ∓ 0.100 vdc
D236	Lo RACS Test	1.030 vdc	1.000 ∓ 0.100 vdc
D236	Amb Output	39.262 psia	14.700 ∓ 70.000 psia
D225	Hi RACS Test	4.010 vdc	1.000 ∓ 0.100 vdc
D225	Lo RACS Test	1.030 vdc	1.000 ∓ 0.100 vdc
D225	Amb Output	16.229 psia	14.700 ∓ 10.000 psia
D016	Hi RACS Test	4.122 vdc *	4.000 ∓ 0.100 vdc
D016	Lo RACS Test	1.123 vdc *	1.000 ∓ 0.100 vdc
D016	Amb Output	75.420 psia	14.700 ∓ 70.000 psia
D019	Hi RACS Test	4.010 vdc	4.015 ∓ 0.100 vdc
D019	Lo RACS Test	1.015 vdc	1.015 ∓ 0.100 vdc
D019	Amb Output	1.888 psia	14.700 ∓ 70.000 psia
D018	Hi RACS Test	4.087 vdc	4.180 ∓ 0.100 vdc
D018	Lo RACS Test	1.097 vdc	1.174 ∓ 0.100 vdc
D018	Amb Output	12.823 psia	14.700 ∓ 15.000 psia
M024	Hi RACS Test	4.010 vdc	4.000 ∓ 0.050 vdc
M024	Lo RACS Test	0.000 vdc	0.000 ∓ 0.050 vdc
M024	Amb Output	5.014 vdc	5.000 ∓ 0.030 vdc
M068	Hi RACS Test	4.025 vdc	4.000 ∓ 0.050 vdc
M068	Lo RACS Test	0.015 vdc	0.000 ∓ 0.050 vdc
M068	Amb Output	5.007 vdc	5.000 ∓ 0.030 vdc
D017	Hi RACS Test	3.989 vdc	4.015 ∓ 0.100 vdc
D017	Lo RACS Test	0.994 vdc	1.020 ∓ 0.100 vdc
D017	Amb Output	16.238 psia	14.700 ∓ 30.000 psia
G001	Amb Output	-0.488°F	-0.300 ± 0.400°F
G002	Amb Output	0.473°F	0.300 ∓ 0.400°F
D020	Hi RACS Test	4.046 vdc	4.000 ∓ 0.100 vdc
D020	Lo RACS Test	1.030 vdc	1.000 ∓ 0.100 vdc
D020	Amb Output	31.782 psia	14.700 ∓ 70.000 psia
D177	Amb Output	14.463 psia	14.700 ∓ 1.000 psia
D178	Amb Output	13.998 psia	14.700 ∓ 1.000 psia

*See revision d.

4.1.23.1 (Continued)

Meas. No	Function	Measurement	Limits
D088	Hi RACS Test	4.005 vdc	4.000 ± 0.100 vdc
D088	Lo RACS Test	0.974 vdc	1.000 ± 0.100 vdc
D088	Amb Output	24.044 psia	14.700 ± 70.000 psia
D179	Amb Output	14.764 psia	14.700 ± 1.000 psia
D180	Amb Output	14.898 psia	14.700 ± 1.000 psia
L007	Amb Output	47.490 pct	50.000 ± 10.000 pct

DP1-B0 Multiplexer Ambient Measurements and High and Low RACS Voltages:

D236	Hi RACS Test	4.015 vdc	4.000 ± 0.100 vdc
D236	Lo RACS Test	1.035 vdc	1.000 ± 0.100 vdc
D236	Amb Output	31.782 psia	14.700 ± 70.000 psia
D043	Amb Output	2356.438 psia	2350.000 ± 120.000 psia
C138	Hi RACS Test	3.994 vdc	4.000 ± 0.075 vdc
C138	Lo RACS Test	-0.010 vdc	0.000 ± 0.075 vdc
C138	Amb Output	69.008°F	65.000 ± 16.000°F
M025	Amb Output	5.010 vdc	5.000 ± 0.030 vdc
D209	Amb Output	14.336 psia	14.700 ± 1.200 psia
D230	Hi RACS Test	4.015 vdc	4.000 ± 0.075 vdc
D230	Lo RACS Test	1.066 vdc	1.000 ± 0.075 vdc
D230	Amb Output	14.885 psia	14.700 ± 1.000 psia
C383	Hi RACS Test	4.020 vdc	4.000 ± 0.075 vdc
C383	Lo RACS Test	0.005 vdc	0.000 ± 0.075 vdc
C383	Amb Output	75.377°F	65.000 ± 32.000°F
D229	Hi RACS Test	3.902 vdc	4.000 ± 0.075 vdc
D229	Lo RACS Test	0.999 vdc	1.000 ± 0.075 vdc
D229	Amb Output	14.330 psia	14.700 ± 1.000 psia
C377	Hi RACS Test	4.015 vdc	4.000 ± 0.075 vdc
C377	Lo RACS Test	-0.005 vdc	0.000 ± 0.075 vdc
C377	Amb Output	73.334°F	65.000 ± 32.000°F
M074	Amb Output	0.000 vdc	0.000 ± 0.075 vdc
M073	Amb Output	0.000 vdc	0.000 ± 0.075 vdc
D016	Hi RACS Test	4.112 vdc *	4.000 ± 0.100 vdc
D016	Lo RACS Test	1.128 vdc *	1.000 ± 0.100 vdc
D016	Amb Output	83.055 psia	14.700 ± 70.000 psia
D014	Amb Output	29.077 psia **	14.700 ± 13.000 psia
D019	Hi RACS Test	4.010 vdc	4.015 ± 0.100 vdc
D019	Lo RACS Test	1.020 vdc	1.015 ± 0.100 vdc
D019	Amb Output	5.471 psia	14.700 ± 70.000 psia
M006	Amb Output	27.938 vdc	28.000 ± 2.000 vdc
M007	Amb Output	0.000 vdc	0.000 ± 1.000 vdc
D050	Amb Output	18.166 psia **	14.700 ± 3.000 psia
D018	Hi RACS Test	4.087 vdc	4.180 ± 0.100 vdc

*See revision d
**See revision e

4.1.23.1 (Continued)

Meas. No	Function	Measurement	Limits
D018	Lo RACS Test	1.092 vdc	1.174 ∓ 0.100 vdc
D018	Amb Output	12.823 psia	14.700 ∓ 15.000 psia
M024	Hi RACS Test	4.010 vdc	4.000 ∓ 0.050 vdc
M024	Lo RACS Test	0.000 vdc	0.000 ∓ 0.050 vdc
M024	Amb Output	5.014 vdc	5.000 ∓ 0.030 vdc
M068	Hi RACS Test	4.035 vdc	4.000 ∓ 0.050 vdc
M068	Lo RACS Test	0.015 vdc	0.000 ∓ 0.050 vdc
M068	Amb Output	5.007 vdc	5.000 ∓ 0.030 vdc
D017	Hi RACS Test	3.989 vdc	4.015 ∓ 0.100 vdc
D017	Lo RACS Test	0.994 vdc	1.020 ∓ 0.100 vdc
D017	Amb Output	17.767 psia	14.700 ∓ 30.000 psia
C006	Hi RACS Test	3.999 vdc	4.000 ∓ 0.075 vdc
C006	Lo RACS Test	-0.056 vdc	0.000 ∓ 0.075 vdc
C006	Amb Output	68.953°F	65.000 ∓ 18.000°F
D103	Amb Output	15.384 psia	14.700 ∓ 3.000 psia
G001	Amb Output	-0.473°F	-0.300 ∓ 0.400°F
G002	Amb Output	0.488°F	0.300 ∓ 0.400°F
M010	Hi RACS Test	4.040 vdc	4.000 ∓ 0.060 vdc
M010	Lo RACS Test	1.056 vdc	1.000 ∓ 0.060 vdc
M010	Amb Output	0.738 vdc	0.000 ∓ 1.000 vdc
D020	Hi RACS Test	4.046 vdc	4.000 ∓ 0.100 vdc
D020	Lo RACS Test	1.040 vdc	1.000 ∓ 0.100 vdc
D020	Amb Output	43.000 psia	14.700 ∓ 70.000 psia
C231	Hi RACS Test	3.974 vdc	4.000 ∓ 0.075 vdc
C231	Lo RACS Test	-0.060 vdc	0.000 ∓ 0.075 vdc
C231	Amb Output	-155.555° F	-155.000 ∓ 8.000° F
C001	Hi RACS Test	3.994 vdc	4.000 ∓ 0.075 vdc
C001	Lo RACS Test	-0.025 vdc	0.000 ∓ 0.075 vdc
C001	Amb Output	66.971°F	65.000 ∓ 72.000°F
D177	Amb Output	14.463 psia	14.700 ∓ 1.000 psia
D178	Amb Output	13.998 psia	14.700 ∓ 1.000 psia
D105	Hi RACS Test	4.015 vdc	4.000 ∓ 0.100 vdc
D105	Lo RACS Test	0.999 vdc	1.000 ∓ 0.100 vdc
D105	Amb Output	11.865 psia	14.700 ∓ 10.000 psia
C230	Hi RACS Test	4.010 vdc	4.000 ∓ 0.075 vdc
C230	Lo RACS Test	0.000 vdc	0.000 ∓ 0.075 vdc
C230	Amb Output	-378.438°F	-379.000 ∓ 4.000°F
D088	Hi RACS Test	4.005 vdc	4.000 ∓ 0.100 vdc
D088	Lo RACS Test	0.984 vdc	1.000 ∓ 0.100 vdc
D088	Amb Output	28.044 psia	14.700 ∓ 70.000 psia
C002	Hi RACS Test	3.994 vdc	4.000 ∓ 0.075 vdc
C002	Lo RACS Test	-0.021 vdc	0.000 ∓ 0.075 vdc
C002	Amb Output	66.018°F	65.000 ∓ 48.000°F
D179	Amb Output	14.703 psia	14.700 ∓ 1.000 psia

4.1.23.1 (Continued)

Meas. No	Function	Measurement	Limits
D180	Amb Output	14.898 psia	14.700 ± 1.000 psia
M026	Amb Output	0.000 vac	0.000 ∓ 1.500 vac
M027	Amb Output	0.000 vac	0.000 ∓ 1.500 vac
M041	Amb Output	0.000 vac	0.000 ∓ 1.500 vac
M040	Amb Output	0.000 vac	0.000 ∓ 1.500 vac
M060	Hi RACS Test	4.040 vdc	4.000 ∓ 0.100 vdc
M060	Lo RACS Test	1.010 vdc	1.000 ∓ 0.100 vdc
M060	Amb Output	1.313 vac	6.000 ∓ 6.000 vac
M061	Hi RACS Test	3.979 vdc	4.000 ∓ 0.100 vdc
M061	Lo RACS Test	1.010 vdc	1.000 ∓ 0.100 vdc
M061	Amb Output	-0.554 vdc	0.000 ∓ 1.000 vdc
L007	Amb Output	47.615 pct	50.000 ∓ 10.000 pct
C199	Hi RACS Test	4.030 vdc	4.000 ∓ 0.075 vdc
C199	Lo RACS Test	-0.025 vdc	0.000 ∓ 0.075 vdc
C199	Amb Output	75.381°F	65.000 ± 21.000°F

LOX and LH_2 Valve Functional Checks

Function	Measurement		Limits
LH_2 & LOX Prevalves	Close Time (sec)	0.483	4.000 max
	Open Time (sec)	2.289	4.000 max
LH_2 Vent Valve	Open Time (sec)	0.113	4.000 max
	Close Time (sec)	0.746	4.000 max
LOX Vent Valve	Open Time (sec)	0.124	4.000 max
	Close Time (sec)	0.372	4.000 max
LH_2 & LOX C/D SOV	Close Time (sec)	0.179	4.000 max
	Open Time (sec)	1.151	4.000 max
LH_2 Vent Valve	Open Time (sec)	0.085	4.000 max
	Close Time (sec)	0.469	4.000 max
	Open Time (sec)	0.085	4.000 max
	Close Time (sec)	0.269	4.000 max
LOX Vent Valve	Open Time (sec)	0.093	4.000 max
	Close Time (sec)	0.352	4.000 max
	Open Time (sec)	0.088	4.000 max
	Close Time (sec)	0.236	4.000 max
LH_2 Fill & Drain Valve	Open Time (sec)	0.271	4.000 max
	Close Time (sec)	2.313	4.000 max
	Open Time (sec)	0.260	4.000 max
	Close Time (sec)	0.922	4.000 max

4.1.23.1 (Continued)

Function	Measurement		Limits
LOX Fill & Drain Valve	Open Time (sec)	0.268	4.000 max
	Close Time (sec)	2.173	4.000 max
	Open Time (sec)	0.255	4.000 max
	Close Time (sec)	0.942	4.000 max
LH_2 & LOX Prevalves	Close Time (sec)	0.438	4.000 max
	Open Time (sec)	2.315	4.000 max
LH_2 & LOX C/D SOV	Close Time (sec)	0.143	4.000 max
	Open Time (sec)	1.122	4.000 max
Dir Vent to Flt Pos	(sec)	0.174	4.000 max
Dir Vent to Grd Pos	(sec)	0.187	4.000 max

Engine Gimbal Step Commands - Restrainer Links Engaged

Position (deg)	Pitch Exc (ma)	Yaw Exc (ma)	TM Pitch Pos(deg)	TM Yaw Pos(deg)	IU Pitch Pos(deg)	IU Yaw Pos(deg)
0° pitch 0° yaw	0.00	0.00	-0.06	0.05	-0.04	0.03
1° pitch 0° yaw	6.55	0.05	0.78	0.05	0.83	0.04
0° pitch 0° yaw	0.00	0.10	-0.05	0.05	-0.03	0.03
1° pitch 0° yaw	-6.70	0.00	-1.07	0.05	-1.03	0.03
0° pitch 0° yaw	-0.10	0.00	-0.06	0.06	-0.01	0.03
0° pitch 1° yaw	0.05	-6.60	-0.06	-0.74	-0.01	-0.74
0° pitch 0° yaw	0.00	0.00	-0.06	0.06	-0.03	0.06
0° pitch 1° yaw	0.00	6.70	-0.06	1.04	-0.06	1.02

4.1.23.1 (Continued)

Restrainer Links Disengaged

Position (deg)	Pitch Exc (ma)	Yaw Exc (ma)	TM Pitch Pos(deg)	TM Yaw Pos(deg)	IU Pitch Pos(deg)	IU Yaw Pos(deg)
0° pitch 0° yaw	-0.10	0.00	-0.06	0.03	-0.03	0.03
0° pitch 0° yaw	0.05	0.00	-0.05	0.05	-0.01	0.03
1° pitch 0° yaw	6.55	0.00	1.00	0.03	1.02	0.03
0° pitch 0° yaw	0.00	0.00	-0.05	0.03	-0.01	0.01
1° pitch 0° yaw	-6.70	0.00	-1.08	0.03	-1.05	0.01
0° pitch 0° yaw	0.00	0.00	-0.03	0.03	-0.01	0.03
0° pitch 1° yaw	0.00	-6.70	-0.06	-0.99	0.01	-0.99
0° pitch 0° yaw	0.00	0.00	-0.05	0.05	-0.01	0.04
0° pitch 1° yaw	0.05	6.65	-0.05	1.05	-0.03	1.03
0° pitch 0° yaw	0.00	0.00	-0.03	0.02	0.00	0.01

Engine Gimbal Frequency Response

Axis (deg)	Desired Freq.	Actual Freq.	Time Lag (TR=T2-T1)	Phase Lag (360)(T3)(F)	Cycles Gimb'd	Sample Time
0.25°Ptch	0.60	0.57	4092.014	0.020	3.18	1.940
	5.00	4.97	0.032	0.066	39.40	1.926
	7.00	6.87	0.023	0.094	70.04	1.930
0.25°Yaw	0.60	0.59	14.000	0.009	3.21	1.963
	5.00	5.02	64.000	0.050	39.71	1.925
	7.00	6.61	66.000	0.047	66.43	1.930

4.1.23.1 (Continued)

Axis (deg)	Desired Freq.	Actual Freq.	Time Lag (TR=T2-T1)	Phase Lag (360)(T3)(F)	Cycles Gimb'd	Sample Time
0.50°Ptch	0.60	0.57	0.021	0.016	3.17	1.941
	5.00	5.00	2.063	0.056	39.44	1.928
	7.00	6.97	0.050	0.091	70.90	1.952
0.50°Yaw	0.60	0.54	34.000	0.012	3.09	1.952
	5.00	3.71	120.000	0.029	30.27	1.961
	7.00	6.92	118.000	0.075	72.23	1.951

4.1.24 Final Prefire Propulsion System Leak Check (1B70175 F)

Final leak checks for the stage propulsion system were conducted prior to acceptance firing to certify the integrity of the system. The primary purpose of the final prefire leak check was to test for any external leakage that could occur as a result of the static acceptance firing.

Checkout was initiated on 5 October 1967, and was completed and certified as acceptable on 9 October 1967. The measurements recorded are listed in Test Data Table 4.1.24.1.

After a preliminary test equipment setup, the checkout was started by taking vacuum readings of the stage vacuum jacketed ducts. All vacuum levels measured were within acceptable limits, as listed in the Test Data Table.

Stage ambient helium system leak checks were conducted next with the pneumatic control sphere and the LOX and LH_2 ambient helium repressurization spheres pressurized with helium to 1400 $\pm$50 psig, and the control regulator discharge pressure set at 515 $\pm$50 psig. These pressures were then locked up and monitored for decay over a 30 minute period. Next the LOX and LH_2 tank prevalves, chilldown valves, vent valves, and fill and drain valves were actuated with helium pressure from the control pneumatics system, while the control helium regulator discharge pressure was monitored for decay during a 15 minute actuation lockup. The results of the ambient helium system decay checks are listed in the Test Data Table. In addition to the decay checks, the pneumatic actuation control modules were checked for internal leakage by monitoring each module for the 6.0 scim allowable leakage at the vent ports. The control

4.1.24 (Continued)

module for the O_2H_2 burner LOX shutdown valve and LH_2 propellant valve was checked for an allowable 20.0 scim combined internal leakage. No unacceptable leakage was detected for any portion of the ambient helium systems.

After satisfactory completion of the ambient helium systems leak check, the cold helium system was leak checked by pressurizing the cold helium spheres with helium to 950 $\pm$50 psig, and checking all plumbing, including the O_2H_2 burner portion of the system, for external leakage with a helium leak detector and AMS 3159 bubble solution. Three leaks noted during this portion of the check were corrected by replacing unions and retightening the B-nuts to the proper torque value.

After completing setup operations for pressurizing the LOX and LH_2 tank assembly, the O_2H_2 burner nozzle plug was installed in preparation for the burner propellant system leak checks. After pressurizing the LOX and LH_2 tank assembly with helium to 5 + 0, -1 psig, the O_2H_2 burner propellant valves and the LOX shutdown valve were individually checked for internal leakage at the burner nozzle plug monitoring ports. No leakage was detected. Next, the burner nozzle plug monitoring ports were capped and the burner propellant valves opened to lockup pressure between the tank assembly and nozzle plug to conduct external leak checks. The entire O_2H_2 burner propellant system was then checked externally for leakage from the tank assembly to the burner nozzle plug. No leaks were reported.

The burner propellant valves were then closed, the downstream systems vented, and the burner nozzle plug removed in preparation for the LOX and LH_2 tank

4.1.24 (Continued)

assembly pressure decay checks. This was accomplished by closing all engine and burner propellant supply valves to maintain static helium pressure in the tank assembly and monitor any loss in tank pressures over a 30 minute period. The pressure requirements were 15 + 0, -1 psig for the LOX tank and 9 + 1, -0 psig for the LH_2 tank. Prior to the decay checks, gas samples were taken from both tanks and analyzed for helium content. Results of the helium concentration check and the pressure decay checks for the LOX and LH_2 tanks are listed in the Test Data Table.

While maintaining LOX tank helium pressure at 15 + 0, -1 psig, the LOX propellant supply line (low pressure duct) to the J-2 engine was pressurized with helium at 15 to 30 psig. The entire LOX propellant supply system, recirculation system, and LOX tank fill and drain line were checked with the helium leak detector and AMS 3159 bubble solution for external leakage from the LOX tank downstream to the J-2 engine, including the LOX turbopump and all related pump discharge plumbing. This included the PU valve, main LOX shutoff valve (MOV), ASI valve, and the gas generator oxidizer circuitry terminating at the gas generator oxidizer valve. No leaks were detected.

After venting the LOX low pressure duct, the LH_2 low pressure duct (propellant supply to the J-2 engine), was pressurized with helium at 10 to 30 psig while maintaining LOX tank and LH_2 tank pressures at 10 to 15 psig and 10 + 0, -1 psig, respectively. The LH_2 system for the LH_2 tank through the J-2 engine was then checked for external helium leakage similarly to the LOX system previously described. One external leak found at the LH_2 fill and drain valve inlet flange was corrected by installing a new seal and a new O-ring.

4.1.24 (Continued)

The J-2 engine thrust chamber throat plug was then installed and helium pressure at 9 + 1, -0 psig was stabilized between the throat plug and the main oxidizer and fuel thrust chamber valves (MOV and MFV) to conduct the thrust chamber leak checks. The entire J-2 thrust chamber system was then checked for external helium leakage. In addition to external leak checks of the thrust chamber system, the actuator drive and idler shaft seal leak checks were conducted for the thrust chamber main oxidizer and main fuel valves. The results are listed in the Test Data Table.

The J-2 engine start system leak check was started by drying the start tank vent valve actuator. A vacuum pump was attached and the actuator housing pumped down to a vacuum of 10 mm of Hg maximum. A heat lamp was applied to the actuator to obtain a surface temperature between 100°F and 150°F. The actuator temperature and vacuum were maintained for a minimum of 2 hours. The start tank system was leak checked by pressurizing the tank with helium to 500 ±10 psig and checking all connections for external leakage with the detector and bubble solution. After allowing the start tank pressure to stabilize for 2 hours, the start tank temperature and pressure were measured and recorded. After 1 hour, these measurements were repeated to calculate the helium mass decay rate for the start tank. The calculated decay rate was 0.00315 lb-mass/hr, which was acceptable based on an allowable mass decay rate of 0.0066 lb-mass/hr.

The J-2 engine control sphere was then pressurized with helium to between 225 and 250 psig in preparation for engine pneumatic leak checks. The low pressure

4.1.24 (Continued)

side leak check was then conducted to determine internal leakage within the engine pneumatic control package. Leakage rates measured at the pneumatic control package common vent port were within the acceptable tolerances, as listed in the Test Data Table. Engine control sphere pressure was then increased to 300 ±10 psig and the helium control solenoid was turned on to pressurize the pressure actuated purge system for external leak checks. No leaks were detected with the helium leak detector or the bubble solution. The engine control sphere pressure was then increased to 1450 ±50 psia for the pneumatic control high pressure side retention test. After allowing the control sphere pressure to stabilize for 1 hour, the control sphere temperature and pressure were measured and recorded to calculate sphere helium mass. This was repeated 1 hour later to obtain a calculated engine control sphere helium mass decay rate of 0.002216 pounds-mass/hour, which was acceptable based on an allowable decay rate of 0.036 pounds-mass/hour.

Following completion of the J-2 engine leak checks, the LOX and LH_2 tanks and the engine systems were purged with helium in preparation for static acceptance firing. After the purge, the LOX and LH_2 tank ullage were set to 5 ±1 psig and 5 + 1, -0 psig, respectively, for the final helium concentration test. Blanket pressures were then established in the LOX and LH_2 tanks. The LOX tank pressure was set at 5 + 0, -1 psig and the LH_2 tank pressure was set at 3 + 0, -1 psig, preparatory to static acceptance firing countdown. The test stand was then secured.

Fifteen revisions were made to the procedure for the following:

a. Eight revisions changed, added, or deleted sections of the procedure that were missing or in error.

4.1.24 (Continued)

b. Six revisions outlined special steps to obtain leakage information for engineering data.

c. One revision deleted venting of the LOX and LH_2 tanks to conserve helium.

4.1.24.1 Test Data Table, Final Prefire Propulsion System Leak Checks

Stage Vacuum Duct Readings

	Indication(Microns)	Limits(Microns)
LH_2 LPD Upper	30	Less than 250
LH_2 LPD Lower	24	Less than 250
LH_2 Recirculation	75	Less than 250
O_2H_2 Burner Propellant Upper	38	Less than 250
O_2H_2 Burner Propellant Lower	5	Less than 250
O_2H_2 Burner Propellant	5	Less than 250

Amb He Sys Press Decay Checks

	Initial	Final	Limits
Cont He Sphere Press (psig)	1375	1360	*
LOX Repress Sphere Press (psig)	1400	1380	*
LH_2 Repress Sphere Press (psig)	1350	1315	*
Cont He Reg Dis Press (psig)	530	530	*

Cont Pneu Sys Press Decay Test

	Initial	Final	Limits
Cont He Reg Dis Press (psig)	530	530	*

LOX and LH_2 Tank He Concentration

	He Concentration (%)	
Location	Indication	Limits
LOX Tank Top	99.84	75 min
LOX Tank Bottom	99.71	75 min
LH_2 Tank Top	99.95	75 min
LH_2 Tank Bottom	99.96	75 min

* Limits Not Specified

4.1.24.1 (Continued)

LOX and LH_2 Tank Pressure Decay Test

Function	Initial	Final	Limits
LOX Tank Pressure (psig)	14.1	14.0	*
LH_2 Tank Pressure (psig)	9.4	9.2	*

Thrust Chamber Valve Actuator Shaft Seal Leak Checks

	Measured	Limits
MOV Idler Leakage (scim)	0	3.3 max
MFV Idler Leakage (scim)	0	3.3 max
MOV 2nd Stage Actuator Leakage (scim)	0	3.3 max
MFV Actuator Leakage (scim)	0	3.3 max

Engine Pneumatic Control Package (Low Pressure Side) Leak Check

	Vent Port Flow	Limits
Helium Control Solenoid On (scim)	6.0	20 max
Ignition Phase Solenoid On (scim)	4.75	20 max
Mainstage Solenoid On (scim)	13.6	20 max

Final LOX and LH_2 Tank He Concentration

	He Concentration (%)	
Location	Indication	Limits
LOX Tank Top	99.75	99 min
LOX Tank Bottom	99.83	99 min
LH_2 Tank Top	99.88	99 min
LH_2 Tank Bottom	99.88	99 min

* Limits Not Specified

4.2 Postfire Acceptance Testing

Stage postfire testing began on 13 October 1967, with the initiation of the stage power setup, paragraph 4.2.1. The postfire checkouts were completed on 8 November 1967, with the acceptance of the forward skirt thermo-conditioning checkout, paragraph 4.2.7. All tests required per End Item Test Plan 1B66684 K dated 20 September 1968 were activated and completed.

4.2.1 Stage Power Setup (1B55813 D)

Prior to initiating postfire test procedures, the stage power setup procedure verified the capability of the GSE automatic checkout system (ACS) to control power switching to and within the stage and ensured that the stage forward and aft power distribution system was not subjected to excessive static loads during initial setup sequences. After the procedure was successfully demonstrated, it was used to establish initial conditions during subsequent postfire automatic procedures.

This procedure was successfully demonstrated on 13 October 1967. The measurements recorded are shown in Test Data Table 4.2.1.1.

The test started by resetting all of the matrix magnetic latching relays; then verifying that the corresponding command relays were in the proper state. Verification was made that the umbilical connectors were mated, and that the LOX and LH_2 inverters were disconnected. The bus 4D119 talkback power was turned on, and the prelaunch checkout group power was turned off. The forward power and the aft power buses were transferred to external power. The sequencer power, engine control bus power, engine ignition bus power, APS bus 1 and bus 2 power, and propellant level sensor power were all verified to be off. The power to the range safety system 1 and 2 receivers and the EBW firing units was transferred to external and verified to be off. The switch selector checkout indication enable and the flight measurement indication enable were turned on.

4.2.1 (Continued)

The bus 4D131, 28 vdc power was turned on, and the forward bus 1 initial current and voltage were measured. The range safety safe and arm device was verified to be in the safe condition.

The 70 pound ullage engine relay, the LH_2 and LOX repressurization mode relay, the LH_2 and LOX repressurization control valve relay, and the O_2H_2 burner propellant valve relay were reset. The LH_2 continuous vent and relief overboard valve was verified to be closed.

The propellant utilization boiloff bias was turned off. The O_2H_2 burner spark systems 1 and 2 voltages were measured and recorded. It was verified that the O_2H_2 burner LOX valve, LOX shutdown valve, LH_2 valve, and the LH_2 continuous vent orificed bypass valve were closed.

The forward bus 1 quiescent current was measured. The PCM system group was turned on, and the amperage of the PCM system group was measured. The cold helium supply shutoff valve was closed. The aft 1 power supply current and voltage were measured, and it was verified that the aft 1 local sensor was off. Sequencer power was turned on, the forward bus 2 current and voltage were measured, and it was verified that the forward 2 local sensor was off.

The prelaunch checkout group power was turned on, and the current was measured. The forward and aft battery load test off commands were set; then the DDAS ground station selector switch was manually set to position 1, and it was verified that the ground station was in sync. The EBW pulse sensor power was turned off.

4.2.1 (Continued)

A series of checks verified that stage functions were in the proper state. Forty functions were verified to be off, and twenty functions were verified to be on. The LOX and LH_2 prevalves and chilldown shutoff valves were verified to be open, and the LOX and LH_2 vent valves and fill and drain valves were verified to be closed.

The final operations measured the forward and aft 5 volt excitation module voltages, the range safety firing unit charging voltages, the aft bus 2 voltages, the forward and aft battery simulator voltages, and the component test power voltages.

No problems were encountered during the test, and no FARR's were initiated. One revision was recorded in the procedure to correct a program error. There were no other problems encountered.

4.2.1.1 Test Data Table, Stage Power Setup

Function	Measured Value	Limits
Forward Bus 1 Power Supply Current (amps)	2.00	20 max
Bus 4D31 Forward 1 Voltage (vdc)	28.48	28 ± 2
O_2H_2 Burner Spark System 1 Voltage (vdc)	0.02	0 ± 0.5
O_2H_2 Burner Spark System 2 Voltage (vdc)	0.00	0 ± 0.5
Forward Bus 1 Quiescent Current (amps)	1.50	5 max
PCM System Group Current (amps)	5.00	5 ± 3
Aft 1 Power Supply Current (amps)	0.10	2 max
Bus 4D11 Aft 1 Voltage (vdc)	28.52	28 ± 2
Sequencer Power (amps)	0.00	3 max
Forward Bus 2 Power Supply Current (amps)	0.10	2 max
Bux 4D21 Forward 2 Voltage (vdc)	28.44	28 ± 2
Prelaunch Checkout Group Current (amps)	2.00	4 ± 4
Aft 5v Excitation Module Voltage (vdc)	5.00	5.00 ± 0.030
Fwd 1, 5v Excitation Module Voltage (vdc)	5.02	5.00 ± 0.030
Fwd 2, 5v Excitation Module Voltage (vdc)	5.00	5.00 ± 0.030
Range Safety 1 EBW Firing Unit Chg Voltage (vdc)	0.00	0 ± 1

4.2.1.1 (Continued)

Function	Measured Value	Limits
Range Safety 2 EBW Firing Unit Chg Voltage (vdc)	0.00	0 ± 1
Bus 4D41 Aft Bus 2 Voltage (vdc)	-0.16	0 ± 1
Bus 4D30 Fwd Battery 1 Voltage (vdc)	0.00	0 ± 1
Bus 4D20 Fwd Battery 2 Voltage (vdc)	-0.04	0 ± 1
Bus 4D10 Aft Battery 1 Voltage (vdc)	-0.04	0 ± 1
Bus 4D40 Aft Battery 2 Voltage (vdc)	-0.08	0 ± 1
Component Test Power Voltage (vdc)	0.64	0 ± 1

4.2.2 Stage Power Turnoff (1B55814C)

The stage power turnoff procedure was used for the automatic shutdown of the stage power distribution system to return the stage to the de-energized condition upon completion of the various stage postfire system checkout procedures. The procedure deactivated stage relays so that no current flowed from the battery simulators through the stage wiring. All internal/external transfer relays were set to the external condition. Satisfactory demonstration of this procedure was accomplished on 13 October 1967, and the stage power turnoff measurement values are tabulated in Test Data Table 4.2.2.1.

Automatic stage power turnoff started by verifying that the umbilical connectors were mated, and that the flight measurement indication enable command was turned on. The bus 4D119 talkback power, the forward bus 1 and aft bus 1, 28 vdc power supplies, and the sequencer power were all verified to be on. The forward bus 1 and aft bus 1 voltages were then measured.

The switch selector functions were then turned off, and a series of checks verified that the stage electrical functions were in the proper state of off or reset. The O_2H_2 burner spark system 1 and 2 voltages were measured. The forward and aft bus power supplies were verified to be off, and the forward and aft bus battery simulator voltages were measured. The stage buses were then transferred to external power, and the forward and aft stage bus voltages were measured. The EBW pulse sensor power was turned off, and the range safety receivers and the EBW firing units were transferred to external power. The range safety system safe and arm device was verified to be on safe, and the

4.2.2 (Continued)

bus 4D119 talkback power was turned off. The matrix magnetic latching relays were then reset; thus completing this demonstration run for stage power turnoff.

There were no FARR's written against this test. One revision was recorded in the procedure to correct a program error. There were no other changes.

4.2.2.1 <u>Test Data Table, Stage Power Turnoff</u>

Function	Measured Value	Limits
Forward Bus 1 Voltage Power On (vdc)	28.64	28 ± 2
Aft Bus 1 Voltage Power On (vdc)	28.44	28 ± 2
O_2H_2 Burner Spark System 1 Voltage (vdc)	0.00	0 ± 0.5
O_2H_2 Burner Spark System 2 Voltage (vdc)	-0.01	0 ± 0.5
Forward Bus 1 Battery Simulator Voltage (vdc)	-0.04	0 ± 2
Forward Bus 2 Battery Simulator Voltage (vdc)	0.00	0 ± 2
Aft Bus 1 Battery Simulator Voltage (vdc)	0.00	0 ± 2
Aft Bus 2 Battery Simulator Voltage (vdc)	-0.16	0 ± 2
Forward Bus 1 Voltage Power Off (vdc)	0.04	0 ± 1.0
Forward Bus 2 Voltage Power Off (vdc)	0.00	0 ± 1.0
Aft Bus 1 Voltage Power Off (vdc)	0.00	0 ± 1.0
Aft Bus 2 Voltage Power Off (vdc)	0.00	0 ± 1.0

4.2.3 Integrated System Test (1B55831 E)

This postfire automatic checkout verified the design integrity and operational capability of the stage and facility systems which were functional during propellant loading and static acceptance firing. The automatic and manual test sequences performed during this checkout were conducted on 13 October 1967, and were accepted on 17 October 1967.

The stage power setup procedure established initial conditions and systematically applied power to stage buses and system required for operation of the test.

The GSE valve functional checkout established an ambient condition in the pneumatic console by bleeding down all regulators and resetting them to predetermined values. All console and sled valves used in propellant loading and static acceptance firing were cycled, and the heat exchanger was functionally checked.

The telemetry and DDAS systems were tested next, with the PCM transmitter operated open loop. The telemetry 5 step calibration high and low RACS, and special calibrations of flows, speed, and frequencies were commanded to provide verification of all calibration techniques. The parameters on the CP1-BO and DP1-BO multiplexers and remote analog and digital submultiplexers, which were required for loading or firing, were verified by receipt of the proper response through open loop PCM transmissions. At the conclusion of the DDAS test, the output was again received by the 600 Hz VCO. During the CP1-BO multiplexer test, thirty-seven functions were verified to be off, and twenty functions were

4.2.3 (Continued)

verified to be on. The DP1-BO multiplexer test verified that seven functions were off, and thirteen were on. Measurements recorded for the multiplexer tests are listed in Test Data Table 4.2.3.1.

The torch and water test was performed satisfactorily. Following setup of the console GH_2 supply, the GH_2 ignitors, the diffuser water, the deflection plate water, and the aspirator water were functioned in sequence. This series of events verified that the proper water pressures and torch ignition signal were received.

During the stage valves and O_2H_2 burner functional checkouts, the LH_2 and LOX vent valves and the fill and drain valves were opened and closed while the valve operating times were measured. Then the LOX and LH_2 valves were opened and boosted closed, and the boost close times measured. The LOX and LH_2 prevalves and chilldown shutoff valves were closed and opened while the operating times were measured. The LH_2 directional vent valve was set to the flight and ground positions while the operating times were measured; then, a simulated O_2H_2 burner firing flight sequence was conducted. Valve operating times are listed in Test Data Table 4.2.3.1.

Engine gimbal testing followed the stage valve functional test. The auxiliary hydraulic pump was operated while verifying the proper pressures and levels prior to and after restrainer link disengagement. The J-2 engine received a step gimbal signal, as well as 1/4 and 1/2 degree sinusoidal inputs at 0.6, 5.0, and 7.0 Hz. The recorded gimbal data are shown in the Test Data Table.

4.2.3 (Continued)

A final dry sequence of the J-2 engine, through the use of simulation commands for ASI ignition and mainstage ignition, was conducted to verify proper engine operation as well as the ESCS spark monitoring circuitry.

The ullage rocket ignition and jettison EBW units were functionally certified by charging and firing into the pulse sensors.

The overfill point level sensors and depletion point level sensors were proven to operate satisfactorily by cycling the sled main fill and replenish valves with 2-out-of-3 depletion sensors verifying the cutoff logic to be operational. In addition, the individual ability to create a cutoff was proven for the engine lockout component test power and engine lockout GSE power.

The propellant utilization system test verified that the inverter-converter outputs were correct and cycled the PU mass bridge, which created positive and negative error signals for verification of the engine PU valve position.

The stage bus internal power was setup by the use of secondary battery power. The forward internal/external cycle was completed by switching normal telemetry current to forward bus 1 and PU current to forward bus 2. Following the APS and range safety functional checks, the aft bus 1 was cycled from internal to external with the stage and APS currents at ambient. The LOX and LH_2 chilldown inverters were operated for current and frequency tests; then, aft bus 2 switched from internal to external. This completed stage testing for the integrated system test.

There were no discrepancies documented against the stage by FARR as a result of the integrated system test. All problem areas were resolved by the thirty-one revisions recorded in the procedure as follows:

4.2.3 (Continued)

a. Eleven revisions concerned correction of TRD, program, and procedure errors.

b. Three revisions updated the program to conform to current design requirements.

c. Three revisions updated the procedure to conform to current design requirements.

d. One revision corrected a typographical error.

e. One revision deleted from the program NASA measurement D054, fuel tank inlet pressure, as authorized by EO 1A81847-A45-6B.

f. One revision deleted the LN_2 vaporizer setup which is required for prefire IST only.

g. Two revisions entered the necessary PU constants into the program.

h. One revision added the required J-2 engine transducer calibration data into the program.

i. One revision authorized a reduction in ejector GN_2 supply pressure from 2100 psig to 1900 psig. The higher pressure is needed only for prefire IST to ensure sufficient pressure for the static firing which normally follows IST.

j. One revision concerned a facility helium regulator bleed valve malfunction not applicable to the stage hardware.

k. Two revisions dealt with GSE system malfunctions which had no effect on the stage hardware.

l. One revision was attributed to a program error of an out-of-tolerance indication for the control helium regulator discharge pressure. The measured value was within specification limits.

m. One revision was attributed to a slow purge pressure rise rate which was caused by a higher than normal seal leakage of the chilldown purge motor container. Although the leakage was acceptable, the program looked for a faster pressure rise rate and indicated the malfunction "LOX chilldown pump bypass purge not on".

n. One revision explained that reception of the SIM channel 85 interrupt was caused by transients in the facility water system, which resulted in the pickup and dropout of the deflector plate water pressure OK switch.

4.2.3 (Continued)

o. One revision obtained ambient output readings manually for measurements D229 and D230, the O_2H_2 burner oxidize injector and fuel injector pressures, because the automatic program had measured out-of-tolerance pressures due to a partial vacuum requirement on the O_2H_2 burner to dry the burner chamber after static firing.

4.2.3.1 Test Data Table, Integrated System Test

CP1-B0 Multiplexer Ambient Measurements and High and Low RACS Voltages

Meas No.	Function	Measurement	Limits
D043	Amb Output (psia)	2370.125	2350.000 + 125.000
M025	Hi RACS Test (vdc)	3.994	4.000 ± 0.050
M025	Lo RACS Test (vdc)	-0.005	0.000 ± 0.050
M025	Amb Output (vdc)	4.998	5.000 ± 0.030
D236	Hi RACS Test (vdc)	4.020	4.000 ± 0.100
D236	Lo RACS Test (vdc)	1.025	1.000 ± 0.100
D236	Amb Output (psia)	20.565	14.700 ± 70.000
D225	Hi RACS Test (vdc)	4.010	4.000 ± 0.100
D225	Lo RACS Test (vdc)	1.015	1.000 ± 0.100
D225	Amb Output (psia)	15.138	14.700 ± 10.000
D016	Hi RACS Test (vdc)	4.025	4.000 ± 0.100
D016	Lo RACS Test (vdc)	1.071	1.000 ± 0.100
D016	Amb Output (psia)	21.956	14.700 ± 70.000
D019	Hi RACS Test (vdc)	4.025	4.035 ± 0.100
D019	Lo RACS Test (vdc)	1.030	1.036 + 0.100
D019	Amb Output (psia)	12.638	14.700 ± 70.000
D018	Hi RACS Test (vdc)	4.081	4.092 ± 0.100
D018	Lo RACS Test (vdc)	1.092	1.097 ± 0.100
D018	Amb Output (psia)	12.823	14.700 ± 15.000
M024	Hi RACS Test (vdc)	4.005	4.000 ± 0.050
M024	Lo RACS Test (vdc)	0.000	0.000 ± 0.050
M024	Amb Output (vdc)	5.013	5.000 ± 0.030
M068	Hi RACS Test (vdc)	3.994	4.000 ± 0.050
M068	Lo RACS Test (vdc)	-0.005	0.000 ± 0.050
M068	Amb Output (vdc)	4.999	5.000 ± 0.030
D017	Hi RACS Test (vdc)	3.984	3.993 ± 0.100
D017	Lo RACS Test (vdc)	0.984	0.992 ± 0.100
D017	Amb Output (psia)	19.294	14.700 ± 30.000
G001	Amb Output (°F.)	-0.426	-0.300 ± 0.400
G002	Amb Output (°F.)	0.378	0.300 ± 0.400
D020	Hi RACS Test (vdc)	4.046	4.000 ± 0.100
D020	Lo RACS Test (vdc)	1.025	1.000 ± 0.100
D020	Amb Output (psia)	31.782	14.700 ± 70.000

4.2.3.1 (Continued)

Meas No.	Function	Measurement	Limits
D050	Amb Output (psia)	16.856	14.700 + 3.000
D018	Hi RACS Test (vdc)	4.087	4.092 ∓ 0.100
D018	Lo RACS Test (vdc)	1.103	1.097 ∓ 0.100
D018	Amb Output (psia)	12.053	14.700 ∓ 15.000
M024	Hi RACS Test (vdc)	3.994	4.000 ∓ 0.050
M024	Lo RACS Test (vdc)	0.000	0.000 ∓ 0.050
M024	Amb Output (vdc)	5.014	5.000 ∓ 0.030
M068	Hi RACS Test (vdc)	3.999	4.000 ∓ 0.050
M068	Lo RACS Test (vdc)	-0.010	0.000 ∓ 0.050
M068	Amb Output (vdc)	5.000	5.000 ∓ 0.030
D017	Hi RACS Test (vdc)	3.999	3.993 ∓ 0.100
D017	Lo RACS Test (vdc)	0.989	0.992 ∓ 0.100
D017	Amb Output (psia)	12.294	14.700 ∓ 30.000
C006	Hi RACS Test (vdc)	4.010	4.000 ∓ 0.075
C006	Lo RACS Test (vdc)	-0.050	0.000 ∓ 0.075
C006	Amb Output (°F.)	79.182	77.000 ∓ 18.000
D103	Amb Output (psia)	17.021	14.700 ∓ 3.000
G001	Amb Output (°F.)	-0.426	-0.300 ∓ 0.400
G003	Amb Output (°F.)	0.394	0.300 ∓ 0.400
M010	Hi RACS Test (vdc)	4.051	4.000 ∓ 0.060
M010	Lo RACS Test (vdc)	1.040	1.000 ∓ 0.060
M010	Amb Output (vdc)	0.646	0.000 ∓ 1.000
D020	Hi RACS Test (vdc)	4.046	4.000 ∓ 0.100
D020	Lo RACS Test (vdc)	1.035	1.000 ∓ 0.100
D020	Amb Output (psia)	31.782	14.700 ∓ 70.000
C231	Hi RACS Test (vdc)	3.974	4.000 ∓ 0.075
C231	Lo RACS Test (vdc)	-0.041	0.000 ∓ 0.075
C231	Amb Output (°F.)	-155.555	-155.000 ∓ 8.000
C001	Hi RACS Test (vdc)	4.005	4.000 ∓ 0.075
C001	Lo RACS Test (vdc)	-0.015	0.000 ∓ 0.075
C001	Amb Output (°F.)	84.514	77.000 ∓ 72.000
D177	Amb Output (psia)	14.583	14.700 ∓ 1.000
D178	Amb Output (psia)	14.178	14.700 ∓ 1.000
D105	Hi RACS Test (vdc)	4.010	4.000 ∓ 0.100
D105	Lo RACS Test (vdc)	0.999	1.000 ∓ 0.100
D105	Amb Output (psia)	11.865	14.700 ∓ 10.000
C230	Hi RACS Test (vdc)	4.005	4.000 ∓ 0.075
C230	Lo RACS Test (vdc)	-0.010	0.000 ∓ 0.075
C230	Amb Output (°F.)	-378.438	-379.000 ∓ 4.000
D088	Hi RACS Test (vdc)	3.979	4.000 ∓ 0.100
D088	Lo RACS Test (vdc)	0.964	1.000 ∓ 0.100
D088	Amb Output (psia)	13.086	14.700 ∓ 70.000
C002	Hi RACS Test (vdc)	4.010	4.000 ∓ 0.075
C002	Lo RACS Test (vdc)	-0.010	0.000 ∓ 0.075
C002	Amb Output (°F.)	74.912	77.000 ∓ 48.000

4.2.3.1 (Continued)

Meas No.	Function	Measurement	Limits
D177	Amb Output (psia)	14.583	14.700 ± 1.000
D178	Amb Output (psia)	14.118	14.700 ∓ 1.000
D088	Hi RACS Test (vdc)	3.979	4.000 ∓ 0.100
D088	Lo RACS Test (vdc)	0.958	1.000 ∓ 0.100
D088	Amb Output (psia)	5.607	14.700 ∓ 70.000
D179	Amb Output (psia)	14.764	14.700 ∓ 1.000
D180	Amb Output (psia)	14.839	14.700 ∓ 1.000
L007	Amb Output (%)	47.490	50.000 ∓ 10.000

DP1-B0 Multiplexer Ambient Measurements and High and Low RACS Voltages

D236	Hi RACS Test (vdc)	4.020	4.000 ± 0.100
D236	Lo RACT Test (vdc)	1.035	1.000 ∓ 0.100
D236	Amb Output (psia)	28.044	14.700 ∓ 70.000
D043	Amb Output (psia)	2372.813	2350.000 ∓ 125.000
C138	Hi RACS Test (vdc)	3.989	4.000 ∓ 0.075
C138	Lo RACS Test (vdc)	-0.021	0.000 ∓ 0.075
C138	Amb Output (°F.)	80.367	77.000 ∓ 16.000
M025	Amb Output (vdc)	4.999	5.000 ∓ 0.030
D209	Amb Output (psia)	13.729	14.700 ∓ 1.200
D230	Hi RACS Test (vdc)	4.010	4.000 ∓ 0.100
D230	Lo RACS Test (vdc)	1.051	1.000 ∓ 0.100
D230	Amb Output (psia)	3.919 †	14.700 ∓ 1.000
C383	Hi RACS Test (vdc)	4.020	4.000 ∓ 0.075
C383	Lo RACS Test (vdc)	0.010	0.000 ∓ 0.075
C383	Amb Output (°F.)	88.590	77.000 ∓ 32.000
D229	Hi RACS Test (vdc)	3.958	4.000 ∓ 0.100
D229	Lo RACS Test (vdc)	0.994	1.000 ∓ 0.100
D229	Amb Output (psia)	3.435 †	14.700 ∓ 1.000
C377	Hi RACS Test (vdc)	4.015	4.000 ∓ 0.075
C377	Lo RACS Test (vdc)	0.010	0.000 ∓ 0.075
C377	Amb Output (°F.)	84.615	77.000 ∓ 32.000
M074	Amb Output (vdc)	0.000	0.000 ∓ 0.075
M073	Amb Output (vdc)	-0.005	0.000 ∓ 0.075
D016	Hi RACS Test (vdc)	4.046	4.000 ∓ 0.100
D016	Lo RACS Test (vdc)	1.092	1.000 ∓ 0.100
D016	Amb Output (psia)	41.050	14.700 ∓ 70.000
D014	Amb Output (psia)	20.565	14.700 ∓ 13.000
D019	Hi RACS Test (vdc)	4.020	4.035 ∓ 0.100
D019	Lo RACS Test (vdc)	1.030	1.036 ∓ 0.100
D019	Amb Output (psia)	16.221	14.700 ∓ 70.000
M006	Amb Output (vdc)	28.368	28.000 ∓ 2.000
M007	Amb Output (vdc)	0.000	0.000 ∓ 1.000

† See revision o.

4.2.3.1 (Continued)

Meas No.	Function	Measurement	Limits
D179	Amb Output (psia)	14.824	14.700 + 1.000
D180	Amb Output (psia)	15.079	14.700 ∓ 1.000
M026	Amb Output (vac)	-0.066	0.000 ∓ 1.500
M027	Amb Output (vac)	0.000	0.000 ∓ 1.500
M041	Amb Output (vac)	-0.066	0.000 ∓ 1.500
M040	Amb Output (vac)	0.000	0.000 ∓ 1.500
M060	Hi RACS Test (vdc)	4.040	4.000 ∓ 0.100
M060	Lo RACS Test (vdc)	1.010	1.000 ∓ 0.100
M060	Amb Output (vac)	2.215	6.000 ∓ 6.000
M061	Hi RACS Test (vdc)	3.979	4.000 ∓ 0.100
M061	Lo RACS Test (vdc)	1.005	1.000 ∓ 0.100
M061	Amb Output (vdc)	-0.308	0.000 ∓ 1.000
L007	Amb Output (%)	47.490	50.000 ∓ 10.000
C199	Hi RACS Test (vdc)	4.025	4.000 ∓ 0.075
C199	Lo RACS Test (vdc)	-0.030	0.000 ∓ 0.075
C199	Amb Output (°F.)	85.381	77.000 ∓ 21.000

Valve Functional Check

Function	Measurement		Limits
LH_2 & LOX Prevalves	Close Time (sec)	0.477	4.000 max
	Open Time (sec)	2.313	4.000 max
LH_2 Vent Valve	Open Time (sec)	0.118	4.000 max
	Close Time (sec)	0.474	4.000 max
LOX Vent Valve	Open Time (sec)	0.116	4.000 max
	Close Time (sec)	0.374	4.000 max
LH_2 & LOX C/D SOV	Close Time (sec)	0.176	4.000 max
	Open Time (sec)	1.149	4.000 max
LH_2 Vent Valve	Open Time (sec)	0.083	4.000 max
	Close Time (sec)	0.451	4.000 max
	Open Time (sec)	0.083	4.000 max
	Close Time (sec)	0.268	4.000 max
LOX Vent Valve	Open Time (sec)	0.092	4.000 max
	Close Time (sec)	0.350	4.000 max
	Open Time (sec)	0.088	4.000 max
	Close Time (sec)	0.241	4.000 max

4.2.3.1 (Continued)

Function	Measurement		
LH_2 Fill & Drain Valve	Open Time	(sec)	0.279
	Close Time	(sec)	2.347
	Open Time	(sec)	0.271
	Close Time	(sec)	0.919
LOX Fill & Drain Valve	Open Time	(sec)	0.264
	Close Time	(sec)	2.175
	Open Time	(sec)	0.260
	Close Time	(sec)	0.939
LH_2 & LOX Prevalves	Close Time	(sec)	0.433
	Open Time	(sec)	2.335
LH_2 & LOX C/D SOV	Close Time	(sec)	0.144
	Open Time	(sec)	1.122
LH_2 Dir Vent Valve	Dir Vent to Flt Pos	(sec)	0.167
	Dir Vent to Grd Pos	(sec)	0.186

Engine Gimbal Step Commands

Restrainer Links Engaged

Position (deg)	Pitch Exc (ma)	Yaw Exc (ma)	TM Pitch Pos(deg)	TM Yaw Pos(deg)	IU Pitch Pos(deg)	IU Yaw Pos(deg)
0^o pitch 0^o yaw	0.05	-0.05	-0.03	0.00	0.00	-0.01
1^o pitch 0^o yaw	6.60	0.00	0.81	0.02	0.90	0.01
0^o pitch 0^o yaw	0.05	0.05	-0.05	0.00	0.01	0.00
1^o pitch 0^o yaw	-6.65	0.00	-1.05	0.00	-1.02	-0.01
0^o pitch 0^o yaw	-0.05	0.00	-0.03	0.02	0.00	-0.01
0^o pitch 1^o yaw	0.00	-6.65	-0.05	-0.86	0.00	-0.86

4.2.3.1 (Continued)

Position (deg)	Pitch Exc (ma)	Yaw Exc (ma)	TM Pitch Pos(deg)	TM Yaw Pos(deg)	IU Pitch Pos(deg)	IU Yaw Pos(deg)
0° pitch 0° yaw	0.00	0.05	-0.06	0.05	0.01	0.04
0° pitch 1° yaw	0.00	6.65	-0.03	1.01	0.00	1.00
0° pitch 0° yaw	0.00	0.00	-0.03	0.00	0.01	0.00

Restrainer Links Disengaged

Position (deg)	Pitch Exc (ma)	Yaw Exc (ma)	TM Pitch Pos(deg)	TM Yaw Pos(deg)	IU Pitch Pos(deg)	IU Yaw Pos(deg)
0° pitch 0° yaw	-0.05	0.00	-0.02	0.02	0.01	0.00
1° pitch 0° yaw	6.65	-0.05	1.00	0.00	1.05	-0.01
0° pitch 0° yaw	0.00	-0.05	-0.08	0.02	0.01	-0.01
1° pitch 0° yaw	-6.70	0.00	-1.07	0.02	-1.03	-0.01
0° pitch 0° yaw	0.00	0.00	-0.03	0.00	0.01	0.01
0° pitch 1° yaw	0.00	-6.65	-0.03	-0.99	0.01	-0.99
0° pitch 0° yaw	-0.05	0.00	-0.03	0.05	0.01	0.03
0° pitch 1° yaw	0.00	6.65	-0.02	1.02	0.01	1.03
0° pitch 0° yaw	0.00	0.00	-0.02	0.00	0.01	0.00

4.2.3.1 (Continued)

Engine Gimbal Frequency Response

Axis (deg)	Desired Freq(Hz)	Actual Freq-F(Hz)	Time Lag-T (sec)	Phase Lag (360xTxF)	Cycles Gimb'd	Sample Time(sec)
0.25°Ptch	0.60	0.60	0.014	0.023	3.24	1.938
	5.00	5.02	0.030	0.079	39.00	1.919
	7.00	7.01	0.021	0.104	70.48	1.944
0.25°Yaw	0.60	0.56	12.000	0.006	3.11	1.917
	5.00	4.97	50.000	0.026	39.10	1.914
	7.00	6.44	67.998	0.051	65.26	1.936
0.50°Ptch	0.60	0.59	0.023	0.017	3.20	1.931
	5.00	5.00	2.064	0.060	38.66	1.912
	7.00	6.92	4094.051	0.090	69.22	1.937
0.50°Yaw	0.60	0.54	30.001	0.011	3.08	1.940
	5.00	3.55	122.000	0.026	28.88	1.948
	7.00	6.61	126.000	0.067	68.57	1.923

4.2.4 Final Postfire Propulsion System Leak Check (1B70175 F)

Final leak checks for the stage propulsion system were conducted after the acceptance firing to certify the integrity of the system. The primary purpose of the final postfire leak check was to test for any external leakage that could occur as a result of the static acceptance firing.

Checkout was initiated on 13 October 1967, and completed and certified as acceptable on 18 October 1967. Measurements recorded are listed in Test Data Table 4.2.4.1.

After preliminary test equipment setup, the checkout started by taking vacuum readings of the stage vacuum jacketed ducts. All vacuum levels measured were within acceptable limits, as listed in Test Data Table 4.2.4.1, with the exception of the lower LH_2 low pressure duct. This duct measured ambient instead of the requirement of less than 250 microns. FARR A261653 was initiated against a shorted thermocouple in this duct which was responsible for the constant ambient reading. The defective thermocouple was removed and scrapped.

Stage ambient helium system leak checks were conducted next with the pneumatic control sphere and the LOX and LH_2 ambient helium repressurization spheres pressurized with helium to 1450 $\pm$50 psig, and the control regulator discharge pressure set at 515 $\pm$50 psig. These pressures were then locked up and monitored for decay over a 30 minute period. Next the LOX and LH_2 tank prevalves, chilldown valves, vent valves, and the fill and drain valves were actuated with helium pressure from the control pneumatics system while the control helium regulator discharge pressure was monitored for decay during a 15 minute actuation lockup. Results of the ambient helium system decay checks are listed in

4.2.4 (Continued)

the Test Data Table. In addition to the decay checks, the pneumatic actuation control modules were checked for internal leakage by monitoring each module for the 6.0 scim allowable leakage at the vent ports. The control module for the O_2H_2 burner LOX shutdown valve and LH_2 prop valve was checked for an allowable 20.0 scim combined internal leakage. No unacceptable leakage was detected for any portion of the ambient helium systems.

After satisfactory completion of the ambient helium systems leak check, the cold helium system was leak checked by pressurizing the cold helium spheres with helium to 950 ± 50 psig, and checking all plumbing, including the O_2H_2 burner portion of the system, for external leakage with a helium leak detector and/or AMS 3159 bubble solution. One external leak was detected at the inlet flange to the LOX tank pressurization module. This was corrected by replacing the seal.

After completing setup operations for pressurizing the LOX and LH_2 tank assembly, the O_2H_2 burner nozzle plug was installed in preparation for the burner propellant system leak checks. Pressurizing the LOX and LH_2 tank assembly with helium to 5 +0, -1 psig, the O_2H_2 burner propellant valves and LOX shutdown valve were individually checked for internal leakage at the burner nozzle plug monitoring ports. No leakage was detected. Next, the burner nozzle plug monitoring ports were capped, and the burner propellant valves opened to lockup pressure between the tank assembly and nozzle plug to conduct external leak checks. The entire O_2H_2 burner propellant system was then checked externally for leakage from the tank assembly to the burner nozzle plug. No leaks were detected.

4.2.4 (Continued)

The burner propellant valve were then closed, the downstream systems vented, and the burner nozzle plug removed in preparation for the LOX and LH_2 tank assembly pressure decay checks. These were accomplished by closing all engine and burner propellant supply valves to maintain static helium pressure in the tank assembly and monitor any loss in tank pressures over a 30-minute period. The pressure requirements were 15 +0, -1 psig for the LOX tank and 9 +1, -0 psig for the LH_2 tank. Prior to the decay checks, gas samples were taken from both tanks and analyzed for helium content. Results of the helium concentration check and the pressure decay checks for the LOX and LH_2 tanks are listed in Test Data Table 4.2.4.1.

While maintaining LOX tank helium pressure at 15 +0, -1 psig, the LOX propellant supply line (low pressure duct) to the J-2 engine was pressurized with helium at 15 to 30 psig. The entire LOX propellant supply system, recirculation system, and LOX tank fill and drain line were checked with the helium leak detector and AMS 3159 bubble solution for external leakage from the LOX tank downstream to the J-2 engine, including the LOX turbopump and all related pump discharge plumbing. This included the PU valve, main LOX shutoff valve (MOV), ASI valve, and the gas generator oxidizer circuitry terminating at the gas generator oxidizer valve. One leak was detected at the LOX tank pressurization module hot gas bypass port and adapter flange. This leak was corrected by installing a new seal.

After venting the LOX low pressure duct, the LH_2 low pressure duct (propellant supply to the J-2 engine) was pressurized with helium at 10 to 30 psig while maintaining LOX tank and LH_2 tank pressures at 10 to 15 psig and 10 +0, -1

4.2.4 (Continued)

psig, respectively. The LH_2 system for the LH_2 tank through the J-2 engine was then checked for external helium leakage, similarly to the LOX system previously described. One external leak was found at the LH_2 fill and drain valve inlet flange, which was corrected by installing a new seal.

The J-2 engine thrust chamber throat plug was then installed, and helium pressure at 9 +1, -0 psig was stabilized between the throat plug and the main oxidizer and fuel thrust chamber valves (MOV and MFV) to conduct the thrust chamber leak checks. The entire J-2 thrust chamber system was then checked for external helium leakage. One leak was detected at the mainstage pressure switch flange on the main LOX thrust chamber valve (MOV), and was corrected by replacing the seal. In addition to external leak checks of the thrust chamber system, the actuator drive and idler shaft seal leak checks were conducted for the thrust chamber valves (MOV and MFV). The results are listed in the Test Data Table.

The J-2 engine start system leak check was started by drying the start tank vent valve actuator. A vacuum pump was attached, and the actuator housing pumped down to a vacuum of 10 mm of Hg maximum. A heat lamp was applied to the actuator to obtain a surface temperature between 100°F and 150°F. The actuator temperature and vacuum were maintained for a minimum of 2 hours. The start tank system was leak checked by pressurizing the tank with helium to 500 $\pm$10 psig and checking all connections for external leakage with the detector and bubble solution. One leak was noted between the J-2 engine start tank fill valve. This was documented as acceptable on FARR A255321, because the seal between the start tank and the fill valve was designed to seal at full

4.2.4 (Continued)

operating pressure, which is approximately twice the leak check pressure. After allowing the start tank pressure to stabilize for 2 hours, the start tank temperature and pressure were measured and recorded. After 1 hour, these measurements were repeated to calculate the helium mass decay rate for the start tank. The calculated decay rate was 0.0060 pounds-mass/hour, which was acceptable based on an allowable mass decay rate of 0.0066 pounds-mass/hour.

The J-2 engine control sphere was then pressurized with helium to between 225 and 250 psig in preparation for engine pneumatic leak checks. The low pressure side leak check was then conducted to determine internal leakage within the engine pneumatic control package. Leakage rates measured at the pneumatic control package common vent port were within the acceptable tolerances, as listed in the Test Data Table. Engine control sphere pressure was then increased to 300 $\pm$10 psig, and the helium control solenoid was turned on to pressurize the pressure actuated purge system for external leak checks. No leaks were detected with the helium leak detector or the bubble solution. The engine control sphere pressure was then increased to 1450 $\pm$50 psia for the pneumatic control high pressure side retention test. After allowing the control sphere pressure to stabilize for 1 hour, the control sphere temperature and pressure were measured and recorded to calculate sphere helium mass. This was repeated 1 hour later to obtain a calculated engine control sphere helium mass decay rate of 0.002 pounds-mass/hour, which was acceptable based on an allowable decay rate of 0.036 pounds-mass/hour.

Following completion of the J-2 engine leak checks, the engine systems were purged with hot helium at 190°F in preparation for storage at STC. A dewpoint

4.2.4 (Continued)

meter was used to verify that the maximum allowable hot gas exhaust system moisture content of 1500 ppm had been obtained. The turbine exhaust system had been purged out through the start tank, and the moisture sample taken was recorded at an acceptable 300 ppm. In addition, the thrust chamber moisture content was measured at 680 ppm, below the 1500 ppm maximum allowable. After the J-2 engine purges were accomplished, the procedure was completed by securing the purges, the stage, and the test stand.

There were no other problem areas documented by FARR other than those previously described. Twenty revisions were recorded in the procedure as follows:

a. Three revisions corrected errors in the procedure.

b. Four revisions authorized special installation setups and convenience modifications to accomplish the leak check and purge requirements.

c. One revision deleted sections of the procedure applicable to prefire checkout only.

d. Three revisions concerned investigation and measurement of internal leakage through the actuation control module for the O_2H_2 burner LH_2 prop valve and LOX shutdown valve. A combined leakage limit of 20.0 scim had been established, and the actual leakage measured was 16.5 scim.

e. One revision authorized a setup to the leak check reverse flow of the cold helium bottle fill check valve. No leakage was detected.

f. Two revisions authorized installation of the LOX prepressurization check valve to permit leak checks of the cold helium system.

g. One revision authorized a setup to leak check the shaft seal of the O_2H_2 burner LOX shutdown valve. No leakage was detected.

h. One revision authorized taking repeat gas samples from the stage propellant tanks for analysis of helium concentration due to the use of desiccants during a weekend halt in operations. The 75 per cent helium minimum concentration requirement was obtained for all samples.

4.2.4 (Continued)

i. One revision deleted the repeat leak check of the LH_2 fill and drain valve inlet flange after seal replacement because of the need to remove this valve for microswitch replacement.

j. Three revisions deleted the preshipment purge requirements and provided instructions for a special prestorage purge of the J-2 engine following completion of leak checks.

4.2.4.1 Test Data Table, Final Postfire Propulsion System Leak Checks

Stage Vacuum Duct Readings

	Reading (Microns)	Limits (Microns)
LH_2 LPD Upper	52	Less than 250
LH_2 LPD Lower	Ambient †	Less than 250
LH_2 Recirculation	93	Less than 250
O_2H_2 Burner Propellant Upper	46	Less than 250
O_2H_2 Burner Propellant Lower	55	Less than 250
O_2H_2 Burner Propellant	2	Less than 250

Ambient Helium System Pressure Decay Checks

	Initial(psig)	Final(psig)	Limits
Control Helium Sphere Pressure	1440	1420	*
LOX Repressurization Sphere Pressure	1450	1440	*
LH_2 Repressurization Sphere Pressure	1410	1390	*
Control Helium Regulator Discharge Pressure	525	530	*

Control Pneumatics System Pressure Decay Test

	Initial(psig)	Final(psig)	Limits
Control Helium Regulator Discharge Pressure	530	530	*

LOX and LH_2 Tank Helium Concentration

	Reading(per cent)	Limits(per cent)
LOX Tank Top	99.5	75 min
Bottom	99.5	75 min
LH_2 Tank Top	99.93	75 min
Bottom	99.86	75 min

† Refer to FARR A261653
* Limits Not Specified

4.2.4.1 (Continued)

LOX and LH_2 Tank Pressure Decay Test

	Initial(psig)	Final(psig)	Limits
LOX Tank	14.4	13.6	*
LH_2 Tank	9.5	9.3	*

Thrust Chamber Valve Actuator Shaft Seal Leak Checks

	Measured(scim)	Limits(scim)
MOV Idler	0	3.3 max
MFV Idler	0	3.3 max
MOV 2nd Stage Actuator	0	3.3 max
MFV Actuator	0	3.3 max

Engine Pneumatic Control Package (Low Pressure Side) Leak Checks

	Vent Port Flow (scim)	Limits(scim)
Helium Control Solenoid On	6.0	20 max
Ignition Phase Solenoid On	5.0	20 max
Mainstage Solenoid On	12.0	20 max

* Limits Not Specified

4.2.5 Postfire Structural Inspection (1B70756 B)

This manual procedure outlined the postfire inspection requirements for the stage. The purpose of the checkout was to verify that static firing was not detrimental to the stage structure, and provided a comparison with the prefire structural inspection results.

The procedure was initiated on 16 October 1967, and was completed on 18 October 1967. The checkout was started with an inspection of the LOX and LH_2 tank assemblies, the thrust structure, the tunnel areas, and the forward and aft skirt assemblies for cracked or debonded brackets, for cracks or deformations in the skin panels, and for chipped or peeled paint. The external ducts, tubes, and spheres were checked for scratches, dings, and corrosion. FARR A261654 reported small tears in the LH_2 tank forward dome mylar covering. These discrepancies were repaired in accordance with drawing requirements.

All bonded supports were verified to be acceptable by performing a "coin tap" test by direction of MR&PM Engineering. The areas inspected included the forward and aft domes, and the main and auxiliary tunnels.

The environmental control plenum, P/N 1B64850, was then inspected for rips and debonded areas, and was found acceptable. This was followed by visual inspection of the stage air bottle, the control helium, the ambient helium, and cold helium spheres for dings, scratches, or other damage.

The engine position verification procedure was conducted to measure the inclination angle of the pitch and yaw planes in order to determine the plane of the base of the engine bell. Next, the envelope clearance check verified that

4.2.5 (Continued)

all forward skirt components did not extend outward more than 8 inches from the outer surface of the LH_2 tank forward dome, with the exception of temperature transducer, P/N 1B67863, or extend inward more than 17 1/2 inches from the forward skirt.

This completed the postfire structural inspection of the stage prior to removal of the stage from Test Stand Beta I. There were no additional discrepancies documented by FARR other than that previously described on FARR A261654.

Seven revisions were recorded in the procedure for the following:

a. Two revisions updated the procedure with the latest part number changes.

b. One revision deleted the removal requirement for one thrust structure door because it was not required for postfire structural inspection.

c. One revision deleted the APS module fit check because installation of the APS modules was scheduled for poststorage operations.

d. One revision deleted the postfire LH_2 tank internal inspection because it was scheduled to be accomplished at the VCL prior to poststorage checkout.

e. One revision deleted the inspection of the aft skirt mating surface. This inspection was performed during the stage removal from the test stand per H&CO 1B39612.

f. One revision postponed reinstallation of the thrust structure doors and fairing covers following completion of structural inspection.

4.2.6 Hydraulic System Postfire Operating and Securing (1B41006 A)

The purpose of this procedure was to obtain postfire closed loop hydraulic fluid samples and to secure the hydraulic system prior to removal of the stage from the test stand for transfer to the VCL.

This procedure was conducted satisfactorily on 16 October 1967. Components of the stage hydraulic system installed during this checkout included the main engine driven hydraulic pump, P/N 1A66240-503, S/N X457808; the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454588; the hydraulic pitch and yaw actuator assemblies, P/N 1A66248-505, S/N's 51 and 53; and the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00034. Accumulator/reservoir assembly, P/N 1B29319-519, S/N 00023, had been previously replaced during static firing countdown operations when internal GN_2 leakage was detected, reference FARR A261644.

Prior to the start of the checkout, the GSE hydraulic pumping unit (HPU), P/N 1A67443-1, was flushed and checked for hydraulic fluid cleanliness, then connected to the stage hydraulic system by pressure and return hoses. The HPU provided high pressure hydraulic fluid to the stage hydraulic system during the checkout.

The accumulator/reservoir was charged with gaseous nitrogen, and the stage auxiliary hydraulic pump air bottle was charged to a pressure of 475 ± 50 psig. Verification was made that all components of the stage hydraulic system were securely installed, and that each hydraulic connection was tightened to the proper torque value. All bleed valves were verified to be closed, and all external signs of hydraulic fluid were rinsed from the system.

4.2.6 (Continued)

With the midstroke locks installed on the hydraulic actuators, the auxiliary hydraulic pump was turned on and operated for 6 minutes, bringing the system pressure to the required 3600 ±100 psig. After shutting down the auxiliary pump, closed loop system fluid samples were obtained, for cleanliness evaluation, from the hydraulic actuators and the reservoir inlet sampling valve. Particle counts for the various micron ranges were acceptable for all samples.

Following closed loop sampling, the hydraulic system was refilled to replace the sampling fluid loss. During the system refill, the HPU was turned on and operated for 3 minutes with system pressure at 3650 psig; then, the shutdown sequence of the procedure was begun.

The shutdown sequence of this checkout included a final air content test, which provided information necessary for system analysis by discharging a portion of the internal system fluid volume overboard. The volume discharged was determined to be a function of fluid thermal expansion under ground operating conditions (0°F to 160°F). The HPU was turned on, and the system pressure was increased to 3650 ±50 psig, the bypass valve was opened, and the HPU turned off. Verification was made that the return pressure gauge indicated a minimum of 200 psig. The shutoff valve was cycled open and closed until the return pressure was reduced to 180 ±5 psig. An empty 100 ml graduate was placed under the drain port, and by cycling the reservoir drain valve open and closed, the return pressure was decreased to 80 ±5 psig. The 11 milliliter volume of fluid bled off was less than the 16 milliliter maximum, as specified per design requirements.

4.2.6 (Continued)

The reservoir oil temperature was measured at $107^{\circ}F$, and a total of 66 milliliters of hydraulic fluid was removed at the drain valve, based on the curve for temperature versus drained fluid volume.

The HPU was disconnected from the stage system and secured. Hydraulic system preparations for stage removal from the test stand included depressurization of the GN_2 accumulator, the stage auxiliary hydraulic pump case, and the air supply bottle. All auxiliary equipment was removed from the hydraulic system, and all sample ports were capped. The accumulator/reservoir drain hose was removed, and a plastic dust cover was installed on the port of the reservoir low pressure relief valve. This completed the securing of the system for stage transfer to the VCL.

There were no recorded discrepancies during this checkout, no FARR's were initiated, and no revisions were recorded in the procedure.

4.2.7 Forward Skirt Thermoconditioning System Postfire Checkout (1B41883 B)

The forward skirt thermoconditioning system was tested in preparation for transfer to the VCL at completion of the stage postfire checkout operations. The procedure utilized the thermoconditioning servicer, P/N 1A78829-1, which had conditioned and supplied the water/methanol heat transfer fluid to the forward skirt thermoconditioning system (TCS), P/N 1B38426-213, during checkout operations.

Checkout included the water/methanol cleanliness test, the specific gravity test, the TCS differential pressure test, the TCS drying procedure, and preparation for shipment. The purpose of the cleanliness test was to ensure against contamination of the water/methanol solution by material that could cause TCS failure by restriction of the flow or cause pump abrasion. The specific gravity test checked for proper water/methanol concentration to obtain valid differential pressure measurements during the TCS, "delta P test", which was conducted to check for correct TCS geometry and flow distribution. A drying procedure utilized gaseous nitrogen to purge the TCS of water/methanol vapor.

The postfire TCS checkout was initiated on 7 November 1967, and was successfully completed and accepted on 8 November 1967. The water/methanol cleanliness test was conducted by circulating water/methanol fluid through the TCS; then, obtaining water/methanol samples. The water/methanol samples were taken to the laboratory for a particle count. The samples were found to be acceptable for each micron range.

Next, the specific gravity and temperature of the water/methanol solution was measured with a hydrometer and thermometer, respectively, to determine that

4.2.7 (Continued)

the solution was within the acceptable mixture range for the required delta P testing band. The delta P test was then conducted by measuring the differential pressure between the TCS supply and return lines from the servicer and by measuring the supply and return temperatures, with a water/methanol flow rate of 7.8 $\pm$0.1 gpm at a supply pressure of 42.0 $\pm$0 psig. The differential pressure was recorded at 15.8 psi with the fluid supply temperature at 80°F and the return temperature at 81°F.

Next, the TCS was purged of water/methanol with GN_2 until a system dryness of 25°F dewpoint was obtained, as verified by the Alnor dewpoint meter.

The final operation consisted of disconnecting and securing the servicer and preparing the TCS for stage transfer to the VCL.

There were no FARR's initiated as a result of this checkout and no discrepancies for the TCS were noted. One revision was recorded in the procedure to delete the TCS leak check. The TCS leak check was accomplished during poststorage operations prior to shipment to FTC.

4.3 Poststorage Acceptance Testing

Stage poststorage checkout began on 14 March 1968, with the performance of the structural inspection, paragraph 4.3.1. The telemetry and range safety antenna system checkout, paragraph 4.3.28, completed the poststorage acceptance testing on 12 June 1968. All tests required per the End Item Test Plan 1B66684 K dated 20 September 1968, were accomplished.

4.3.1 Poststorage Structural Inspection (1B70756 B)

This manual procedure outlined the poststorage pre-coldflow and post-coldflow inspection requirements for the stage. The purpose of this checkout was to verify that storage and the coldflow test were not detrimental to the stage structure and that the stage was structurally ready for flight. Two issues of this procedure were required. The first issue was conducted from 14 March through 30 April 1968, prior to the coldflow evaluation test. The second issue was conducted from 15 May through 24 June 1968, after the coldflow evaluation test.

The first issue was initiated on 14 March 1968, with a visual inspection for rips, debonding, or other damage to the external insulation on the aft dome of the LOX tank and the environmental control plenum sphere. This was followed by an inspection of the control helium, helium storage, compress gas, and cold helium spheres. These areas were documented as acceptable prior to the coldflow test; however, reinspection per the second issue on 15 May 1968, after the coldflow test, revealed one tear and a debonded area in the aft dome mylar covering. These discrepancies were repaired per DPS 22301. Also, the silicone rubber seals at both ends of the two cold helium spheres were torn loose, necessitating repairs. All discrepancies were documented on IIS 384034.

Initial inspection of the LOX and LH_2 tank assembly, thrust structure, tunnel areas, and the forward and aft skirt assemblies was conducted on 15 March 1968, for cracked or debonded brackets, cracks or deformation skin panels, and chipped or peeled paint. The external ducts, tubes, and spheres were checked for scratches, dings, and corrosion. No discrepancies were documented; however, the

4.3.1 (Continued)

post coldflow inspection on 17 May 1968, revealed several discrepant conditions which were documented on IIS 384034. All minor discrepancies were cleared from the IIS per Engineering instructions. The major discrepancies were documented on FARR's 500-226-331 and 500-226-480.

All bonded supports for the propellant tank forward and aft domes and the tunnel areas were checked for bond continuity by the coin tap test per DPS 32330, and determined to be acceptable before and after the coldflow test.

The APS modules were installed on the stage at positions I and III for the post-storage APS module fit check and other APS checkouts. The alignment of the APS support structural installation was checked and designated as acceptable on 11 April 1968. After completion of the poststorage APS checkouts, the APS modules were removed from the stage per this procedure and returned to the Gamma area for storage.

The envelope clearance check of the forward skirt components was accomplished on 20 May 1968, after the coldflow test. The hardware mounted on the forward dome was checked to verify that all components, with the exception of the temperature transducer, P/N 1B67863, were not extended more than 8 inches outward from the outer surface of the dome. Verification was also made that stage hardware was not extended inward more than 17 1/2 inches from the forward skirt.

Upon completion of poststorage operations, the second issue of this procedure was used to reinstall all fairing covers and thrust structure access doors, after verifying that the cleanliness of the thrust structure interior and the tunnel areas. This completed the poststorage inspection.

4.3.1 (Continued)

There were no discrepancies recorded for the initial poststorage issue of the procedure conducted prior to the coldflow test. The major problems encountered during the post-coldflow inspection were documented on the following FARR's:

a. FARR 500-226-331 noted that there were missing cap assemblies, P/N 1B42355-1, from the top of the aft skirt stringers 29 and 30. The missing parts were replaced per drawing requirements.

b. FARR 500-226-480 noted that the Korotherm coating in the auxiliary tunnel area on the forward skirt was cracked, loose, and missing, and that the upper conoseal clamp on the fill and drain valve was damaged. These discrepancies were corrected to drawing requirements.

There were six revisions recorded in the initial poststorage procedures and four in the post-coldflow procedure as follows:

a. Three revisions corrected part numbers listed in the procedure to comply with the current drawing requirements for the stage hardware.

b. One revision corrected a procedural error.

c. One revision deleted the engine position verification check which had been previously accomplished during the postfire issue of this procedure. Refer to paragraph 4.2.5.

d. One revision, in the initial poststorage issue, authorized the sweeping of debris from the area between the thrust structure and the aft dome to verify that no damaging items were trapped against the LOX tank skin prior to pressurization.

e. One revision authorized repeating the sphere inspection for the control helium, helium storage, compressed gas, and cold helium spheres on 30 April 1968, to verify sphere conditions immediately prior to the cold flow test.

f. One revision, in the initial issue, deleted those procedures intended to be accomplished by the second issue after the coldflow test.

4.3.1 (Continued)

g. One revision, in the post-coldflow issue, deleted inspection operations previously accomplished in the initial poststorage issue of the procedure.

h. One revision deleted the internal inspection of the LH_2 tank which was not required for Stage 505N after the coldflow test.

4.3.2 Propulsion Leak and Functional Check (1B71877 B)

This procedure defined the operations required to perform the leak and functional checks which certified the stage propulsion system subsequent to static firing. All portions pertaining to S-IB stages and prefire operations were deleted.

The propulsion leak and functional check was conducted twice during poststorage operations, before and after the stage coldflow evaluation. The first issue was conducted between 4 April 1968 and 26 April 1968, and the second issue between 3 May 1968 and 27 May 1968. The discussion that follows covers operations and problems that occurred during both issues, and the measurements listed in Test Data Table 4.3.2.1 are limited to the final issue on 3 May 1968.

The O_2H_2 burner spark ignitor gap and tip alignment check necessitated removal of the injector assembly and visual verification that the porcelain insulator and and the gaps between the ignitor tip shoulder and the insulator had been insulated with a 1/16 inch thick coat of Dow Corning No. 4 compound. The ignitor tip alignment was then checked using a gauge tool, P/N 1B67188-1, with the gauge indicator dial zeroed using a block, P/N 1B67188-3. Inspection Item Sheet (IIS) 383683 reported that the ignitor tip gap for injector No. 1 indicated 0.010 inches on the gauge. After adjustment of the tip to the required dial indication of $\pm$.005 inch, injector No. 2 was checked and found to be within the specified tolerance.

The O_2H_2 burner spark ignitor arcing check consisted of visual observation of the spark gap for constant arcing across the plate while the exciter power was on. The observation was accomplished by sighting through the 9/16 inch diameter

4.3.2 (Continued)

hole in the gauge assembly, P/N 1B67184-1, which was installed into the O_2H_2 burner adapter flange. This checkout was repeated on the spark ignitor No. 2. The O_2H_2 burner checks were accomplished during the first issue only.

The umbilical quick disconnect check valve leak check was performed next. The umbilical quick disconnects were removed, and pressure was applied to the stage side of the check valve. A flowmeter was then connected to the stage quick disconnect. During the second issue, only the LOX tank prepressure supply quick disconnect was checked. There was no leakage noted, and this section was satisfactorily completed.

The calip pressure switch system leak check performed a decay check of the LOX and LH_2 pressure switch checkout circuits by pressurizing the system to 30 ±5 psia and monitoring it for 5 minutes. A leak check of the system was then accomplished. This decay check was deleted during the second issue. A decay and leak check of the mainstage pressure switches was accomplished by pressurizing the system to 400 ±50 psig through the customer connect panel, isolating the mainstage switches from the supply source, leak checking the system, and then monitoring for 15 minutes for any pressure decay. During the first issue, the decay check was deleted.

An audible leak check of the engine control system and the engine start tank system was accomplished during the second issue. After pressurizing the engine control sphere to 350 ±50 psia, and the start tank to 250 ±50 psia, the two systems were verified to be free of any leakage.

4.3.2 (Continued)

The ambient helium system leak and flow check was accomplished next. The first issue began with an orifice flow verification of the purge system, a reverse leak check of the valves, and a leak check of the purge system. An internal leak check of the ambient helium fill module and the pneumatic power control module was performed next. The control helium system was functioned and checked for leakage; then, a leak check of the APS helium bottle fill manifold was accomplished. The second issue began with a leak check of the purge system. An internal leak check of the ambient helium fill module and the pneumatic power control module was performed next. The ambient LOX and LH_2 repressurization system was functioned and checked for internal leakage, followed by a reverse leakage check of the ambient helium sphere fill system check valves. The control helium system was functioned and checked for leakage. The pneumatic control system was locked up and checked for pressure decay over a 30-minute period.

During the first issue, IIS 387683 reported that the LH_2 continuous vent module bellows purge flow rate was 2.3 scim and the orifice bypass valve microswitch housing purge rate was 40 scim. The purge flow rates should have been 70 ± 30 and 3.5 ± 2 scim, respectively; therefore, the orifices were replaced with the proper sizes, and the flow rates were verified to be within specifications. There were three conditions of leakage noted during the first issue. All leaks were corrected by retightening the affected B-nuts. A total of four leaks were noted during the second issue. Failure and Rejection Report (FARR) 500-226-374 reported two leaks on the LOX prevalve and a blowing leak on the LOX nonpropulsive vent blank flange at fin line No. 3. These items were

4.3.2 (Continued)

subsequently accepted for use without rework. The FARR further documented a leak at a sleeve on the auxiliary flight instrumentation package. The leakage condition was corrected by rewelding the sleeve by Rocketdyne personnel.

The engine start system leak and functional checks, accomplished during the second issue, included a drying sequence for the start tank vent valve actuator, a seat leak check of the start tank control solenoid valve, and a reverse leak check of the start tank fill check valve. Leak checks were performed on the GH_2 start system, the start tank dump-control solenoid seal, and the vent and relief valves and valve bellows. Start bottle retention tests were conducted to measure the start bottle decay by calculating the pound-mass/hour-loss. All tests of the engine start system were satisfactorily completed.

The LH_2 pressurization and repressurization system leak and functional checkouts were accomplished during both issues of the procedure and included a functional check of the O_2H_2 burner LH_2 repressurization control valves, a reverse leak test of the O_2H_2 burner LH_2 check valve, and leak checks of the repressurization system and the O_2H_2 burner LH_2 repressurization control valve seat and pilot bleed valve. This section also performed a reverse leak test of the fuel pressure module check valve and the LH_2 prepressurization check valve. There were three leakage conditions noted during this section, two were associated with the first issue and one with the second issue. All leaks were corrected by replacement of seals and retightening of the B-nuts.

Thrust chamber leak checks included a leak check of the thrust chamber system, reverse leakage of the engine LOX dome purge check valve, and flow checks of

4.3.2 (Continued)

the main fuel and oxidizer valve drive and idler shaft seals. This section also covered reverse leakage of the thrust chamber jacket purge check valves. Five conditions of leakage were noted during this section, which was accomplished in the second issue. One leak was corrected by retightening the attach bolts on the ignition detector probe. FARR 500-226-277 reported that a bubbling leak between pipe assemblies 422 and 423 was corrected by rebrazing and that a heavy fuzz leak between tube assemblies 389 and 290 and a bubble leak at the leak check port between the injector and the thrust chamber were acceptable without rework.

The LOX pressurization and repressurization system leak and functional checks performed a reverse leak check of the cold helium sphere fill check valve, an internal leak and functional check of the LOX pressurization module, a LOX pressurization system leak check, a leak and functional check of the O_2H_2 burner LOX repressurization system, a LOX repressurization system leak check, and a cold helium system leak check. Seven conditions of leakage were noted during these checks. Five leaks were repaired by replacement of the seals and retightening the coupling to the required torque value. One leak in a sleeve at the auxiliary flight instrumentation package was repaired by rewelding the sleeve. FARR 500-226-374 reported that the cold helium shutoff valve in the cold helium fill module, P/N 1B42290-505, exceeded the established valve seat and pilot valve leakage of less than 12.5 scim. The module was removed and replaced.

Leak checks were then performed on the LOX tank, the O_2H_2 burner, and the engine LOX feed system. Internal leak checks of the engine feed system checked

4.3.2 (Continued)

for seat leakage of the LOX prevalve and chilldown shutoff valve, the engine LOX bleed valve, the engine main oxidizer valve, and for reverse leakage of the LOX chilldown return check valve. Then the LOX tank and the engine feed system were leak checked. The LOX turbopump was checked for breakaway torque, running torque, and primary seal leakage. The LOX chilldown pump purge flow checks included checks of the LOX chilldown pump purge flow and chilldown pump bypass flow, seat leakage checks of the chilldown pump purge module shutoff valve and the chilldown pump purge dump valve, seal leakage checks of the chilldown pump shaft (in the pump direction and in the tank direction), and a general leak check of the chilldown pump purge system. Several problems were associated with this section. FARR 500-226-374 reported that a black light inspection of the injector and thrust chamber throat areas showed evidence of contamination. Investigation indicated that the contaminate was not detrimental to the engine, and the J-2 engine was acceptable.

The LOX prevalve shaft seal was leak checked with the prevalve open and closed. The LOX fill and drain valve was checked for seat leakage. Next, leak checks of the LOX umbilical and the main fill and replenish valve seat were performed. Seat leakage checks of the O_2H_2 burner LOX propellant valve and LOX shutdown valve and a leak check from the LOX tank to the O_2H_2 burner LOX propellant valve were performed.

Leak checks were then performed on the LH_2 tank, the O_2H_2 burner, and the engine feed system. Internal leak checks of the engine feed system checked for seat leakage of the LH_2 prevalve and chilldown shutoff valve, the engine LH_2 bleed valve, the engine main fuel valve, and checked for reverse leakage of the LH_2

4.3.2 (Continued)

childdown return valve. The LH_2 engine pump drain check valve, the LH_2 turbine seal cavity purge check valve, and the LOX turbine seal cavity check valve were checked for reverse leakage. The LH_2 engine pump intermediate seal was checked for leakage. The LH_2 engine pump drain check valve was also checked for forward flow. Then the LH_2 tank and the engine feed system were leak checked. Next, the LH_2 turbopump was checked for breakaway and running torque and for primary seal leakage.

The LH_2 prevalve shaft seal was leak checked with the valve opened and closed. The LH_2 fill and drain valve was checked for seat leakage. Leak checks of the LH_2 umbilical and the main fill and replenish valve seat were performed. Leak checks of the O_2H_2 burner LH_2 propellant valve seat and the LOX shutdown valve seat were made, as well as a general leak check of the O_2H_2 propellant system. The leak check log documented a leak at the tube assembly stub-out at the LH_2 pump. The stub-out was rewelded, and no further leakage was detected.

Leak and flow checks of the engine gas generator (GG) and exhaust system were conducted next, and included reverse leak checks of the GG LH_2 purge check valve, the GG LOX purge check valve, and the GG LOX poppet. Leak checks of the start tank discharge valve gate seal and the hydraulic pump seal were conducted. A bleed flow check of the LH_2 and LOX turbine seal cavity was conducted. General leak checks of the GG and exhaust system and the pressure actuated purge system were also conducted. IIS 383683 reported that two hardwire stub-outs, GF-4 and TG-4, at the auxiliary flight package, did not have closures welded to the stub-out. The closures were welded to the stub-outs, and this section was satisfactorily completed.

4.3.2 (Continued)

Engine pump purge leak and flow checks performed a regulation check of the engine pump purge module discharge pressure, measured the seat leakage of the engine pump purge valve, checked the purge flows of the LOX and LH_2 turbine seal cavity bleed exits and the LH_2 pump drain test port, and verified the GG fuel purge flow of the LH_2 turbopump access. IIS 383683 reported that old seals were found to have been installed between the stage pneumatic line and the oxidizer turbine bypass valve (OTBV) and between the OTBV, exhaust manifold, and the LOX turbine bypass duct. After replacement of these seals and leak checks of the affected connections, this section was completed.

Leak and flow checks of the engine pneumatics included the helium control solenoid energized leak checks, the LOX intermediate seal purge flow checks, the ignition phase solenoid energized leak checks, the main stage control solenoid energized leak checks, the pressure actuated purge system leak checks, and the engine control bottle fill system leak checks. Also, the engine control bottle retention tests were conducted to determined the control bottle decay by calculating the pound-mass/hour-loss. The leak check log documented three conditions of leakage. One leak was repaired by seal replacement and re-tightening to the proper torque value. The two other leaks, one at a sleeve on the tube assembly at the NN1 transducer above the primary flight instrumentation package and another at the sleeve cap on the NN1 tee, were repaired by rewelding the sleeves.

4.3.2 (Continued)

LOX and LH_2 vent system leak and flow checks included leak checks of the nonpropulsive vent ducting; the nonpropulsive vent and ground system vent; the LOX and LH_2 vent systems; the LOX vent and relief; the relief valve internal leakage; the LH_2 vent and relief, relief, and directional vent valve internal leakage; and an actuator piston leak check of the LH_2 directional vent. Seven leakage conditions were noted during this section. Two leaks reported in the leak check log were transferred to stage IIS 383883. The leaks were eliminated by seal replacement and retightening to the proper torque value. Five other leaks documented on FARR A270657 were associated with the LOX nonpropulsive vent system. The leaks were eliminated by seal replacement and smoothing operations on the sealing surfaces.

There were one hundred and two revisions written against the two issues of this procedure for the following:

a. Twenty-six revisions corrected and/or added requirements that were in error or missing.

b. Twenty-two revisions were required to update the procedure to the latest configuration.

c. Seventeen revisions added steps to acquire additional data and make temporary hardware installations.

d. Eight revisions were incorporated to leak check hardware which was replaced subsequent to system leak checks.

e. Eight revisions changed or deleted previous revisions or portions thereof.

4.3.2 (Continued)

f. Six revisions repeated leak checks and/or requirements previously accomplished.

g. Four revisions deleted portions of the procedure that were prefire checks.

h. Four revisions added steps required to accomplish the special coldflow test.

i. Three revisions deleted leak checks that were previously accomplished.

j. One revision added a note to warn against introducing bubble soap solution into the J-2 engine system.

k. One revision changed the procedure to prevent damage to the LH_2 directional vent valve.

l. One revision authorized substituting a 19 psig burst disk for a 15 psig burst disk. The proper burst disk was not available.

m. One revision authorized the use of a 0-1000 psi gauge in place of a 0-100 psi gauge. The correct gauge was not available.

4.3.2.1 Test Data Table, Propulsion Leak and Functional Check

Calip Pressure Switch Leak Checks

Function	Measurement	Limits
LOX Press Sw C/O Circuit Decay (psi)	0.0	0.5 max/5 minutes
LH_2 Press Sw C/O Circuit Decay (psi)	0.0	0.5 max/5 minutes
Low Press Sw C/O Circuit Decay (psi)	0.0	0.5 max/5 minutes
Eng Mnstg Press Sw Diaph Decay:		
Initial (psig)	396.00	*
Final (psig)	391.50	
Decay (psi)	4.50	10.0 max/15 minutes

Ambient Helium System Flow Checks

Function	Measurement	Limits
LOX Tnk Ullage Sense Line Purge (scim)	350.0	432 ± 245
LOX F&D Vlv Microsw Housing Purge (scim)	2.3	3.5 ± 2
LH_2 F&D Vlv Microsw Housing Purge (scim)	1.6	3.5 ± 2
LH_2 C/D Shutoff Vlv Microsw Purge (scim)	5300.0	6500 ± 2450
LH_2 Prop Vlv Microsw Purge (scim)	1.7	3.5 ± 2
Nonpropulsive Vent Duct Purge (scim)	330.0	432 ± 245
Contin Vent Mod Purge (scim)	40.0	70 ± 40
Orifice Bypass Vlv Microsw Purge (scim)	2.3	3.5 ± 2
Contin Vent Duct Purge (scim)	245.0	432 ± 245

Purge System Check Valve Reverse Leak Checks (P/N 1B51361-1)

Function	S/N	Measurement	Limits
LOX Vent Purge (scim)	355	0.0	10 max
LOX Fill & Drain Purge (scim)	294	0.0	10 max
LH_2 Fill & Drain Purge (scim)	194	0.0	10 max
LH_2 Vent Purge (scim)	292	0.0	10 max

Ambient He Fill Module Internal Leak Checks (P/N 1A57350-507-002, S/N 0232)

Function	Measurement	Limits
Dump Valve Seal Leakage (scim)	0.0	0

Ambient He Spheres Fill System Check Valves Reverse Leak Checks (P/N 1B51361-1)

Function	S/N	Measurement	Limits
LOX Repress Mod Check Vlv (scim)	-	0.0	10 max

* Limits Not Specified

4.3.2.1 (Continued)

Function	S/N	Measurement	Limits
LH_2 Repress Mod Backup Check Valve (scim)	290	0.0	10 max
LH_2 Repress Mod Check Vlv (scim)	-	0.0	10 max
He Fill Mod Backup Check Vlv (scim)	309	0.0	10 max

Ambient Repress Moduel Control Valve Functional Checks

LOX Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0.0	*
Cont Vlv (L2) Seat Leakage (scim)	0.0	*
Module Dump Vlv Seat Leakage (scim)	0.0	*
Mod Dump Vlv Pilot Bleed (scim)	0.0	*
Mod Dump Vlv Seat & Pilot Bleed Leakage (scim)	0.0	9 max
Cont Vlv (L2) Pilot Bleed Leakage (scim)	0.0	*
Cont Vlv (L2) Seat & Pilot Bleed Leakage (scim)	0.0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0.0	*
Cont Vlv (L3) Seat & Pilot Bleed Leakage (scim)	0.0	9 max

LH_2 Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0.0	*
Cont Vlv (L2) Seat Leakage (scim)	0.0	*
Module Dump Vlv Seat Leakage (scim)	0.0	*
Module Dump Vlv Pilot Bleed Leakage (scim)	0.0	*
Mod Dump Vlv & Pilot Bleed Seat Lkg (scim)	0.0	9 max
Mod Cont Vlv (L2) Pilot Bleed Lkg (scim)	0.0	*
Cont Vlv (L2) Seat & Pilot Bleed Lkg (scim)	0.0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0.0	*
Cont Vlv (L3) Seat & Pilot Bleed Leakage (scim)	0.0	9 max

Pneumatic Power Control Module Internal Leak Check (P/N 1A58345-519, S/N 1039)

Function	Measurement	Limits
Control He Shutoff Seat Leakage (scim)	0.0	10 max
Control Module Reg Lockup Press (scim)	529	550 max

* Limits Not Specified

4.3.2.1 (Continued)

Actuation Control Module Checks (P/N 1B66692-501)

Function	S/N	Normal	Open	Closed	Limits
O_2H_2 Burner LOX Vlv Control (scim)	84	0.0	0.0	0.0	6 max
O_2H_2 Burner LH_2 Vlv Control (scim)	85	0.0	0.0	0.0	6 max
Orificed Bypass Vlv Control (scim)	32	0.0	0.0	0.0	6 max
O_2H_2 Burner LH_2 Vlv/LOX S/D Vlv (scim)	85	0.0	0.0	0.0	6 max
		Normal	Open	Boost	
LOX Vent Vlv Control (scim)	24	0.0	0.0	0.0	6 max
LH_2 Fill & Drain Vlv Control (scim)	27	0.0	0.0	0.0	6 max
LOX Fill & Drain Vlv Control (scim)	26	0.0	0.0	0.0	6 max
LH_2 Vent Vlv Control (scim)	33	0.0	0.0	0.0	6 max

Function	S/N	Open	Closed	Limits
LH_2 F&D Act Seal Leakage (scim)	27	0.0	0.0	2 max
LOX F&D Act Seal Leakage (scim)	26	0.0	0.0	2 max
LOX S/D Vlv Act Piston & Shaft Seal Lkg (scim)	-	0.0	0.0	20 max
LH_2 Control Vent Act Piston & Shaft Seal Lkg (scim)	-	0.0	0.0	20 max
		Normal	Closed	
Prevlv C/D Vlv Act Control (scim)	25	0.0	-	6 max
Prevlv Act Control (scim)	25	-	0.0	6 max
C/D Act Control (scim)	25	-	0.0	6 max

Function	S/N	Normal	Flight	Ground	Limits
Bi-Direct Vent Vlv Act Control (scim)	53	0.0	0.0	0.0	6 max

Pneumatic Control System Decay Checks

Function	Measurement Initial	Measurement Final	Limits
Reg Disch Press - Valve Pos, Normal (psig)	525.0	516.0	*
Reg Disch Press - Valve Pos, Activated (psig)	524.0	504.0	*

* Limits Not Specified

4.3.2.1 (Continued)

Engine Start Tank Leak Checks

Function	Measurement	Limits
Vent Control Solenoid Seat Leakage (scim)	0.0	10 max
Initial Fill, Check Vlv Reverse Lkg (scim)	0.0	2 max
Vent & Relief Valve Seat Leakage (scim)	0.0	2 max
Dump Valve Bellows Leakage (scim)	0.0	0
Bottle Decay (Delta M) (lb-mass/hr)	0.0063	0.0066 max

LH_2 Repressurization System Leak Checks

Function	Measurement	Limits
O_2H_2 Burner Control Vlv Seat Lkg (scim)	0.0	*
O_2H_2 Burner Control Vlv Pilot Bleed Lkg (scim)	0.0	*
O_2H_2 Burner Mod Cont Vlv Int Lkg (scim)	0.0	12 max
O_2H_2 Burner Cont Vlv & Check Vlv Rev Lkg (scim)	0.0	*
O_2H_2 Burner Check Vlv Reverse Lkg (scim)	0.0	5 max
O_2H_2 Burner Coil Leakage (scim)	0.0	0

LH_2 Pressurization System Leak Check

Function	Measurement	Limits
LH_2 Press Module Check Vlv Rev Lkg (scim)	0.0	10 max
LH_2 Prepress Check Vlv Rev Lkg (scim)	0.0	0

Thrust Chamber Checks

Function	Measurement	Limits
LOX Dome		
Purge Check Valve Reverse Lkg (scim)	0.0	4 max
Main Oxidizer Valve		
Idler Shaft Seal Leakage (scim)	0.0	10 max
Drive Shaft Seal Leakage (scim)	0.0	10 max
Main Fuel Valve		
Idler Shaft Seal Leakage (scim)	0.0	10 max
Drive Shaft Seal Leakage (scim)	0.0	10 max
Thrust Chamber		
Pressure (psig)	24.0	20 min
Jacket Purge Check Vlv Rev Lkg (scim)	0.0	25 max

* Limits Not Specified

4.3.2.1 (Continued)

LOX Pressurization & Repressurization System Leak Checks

Function	Measurement	Limits
Cold Helium Sphere		
Fill Check Vlv Rev Lkg (scim)	0.0	0
Shutoff Vlv Seat & Pilot Bleed Lkg (scim)	53.0 †	12.5 max
LOX Press Module Internal		
Hot Gas Bypass Vlv Seat & Pilot Bleed Lkg (scim)	440.0	1000 max
O_2H_2 Burner LOX Repress System		
Burner Control Valve Seal Leakage (scim)	0.0	*
Burner Control Valve Pilot Bleed Lkg (scim)	0.0	*
Burner Module Control Vlv Internal Lkg (scim)	0.0	12 max
System Check Valve Reverse Leakage (scim)	0.0	5 max
Combined Burner Check Vlv & Cont Vlv Seat Leakage (scim)	0.0	0
Burner Check Vlv Rev Leakage (scim)	0.0	0
Burner Coil Leakage (scim)	0.0	0
Cold Helium System		
LOX Tank Prepress Check Vlv Rev Lkg (scim)	0.0	0

LOX Tank O_2H_2 Burner & Engine Feed System Leak Checks

Function	Measurement	Limits
LOX Tank Helium Content		
Top (%)	96.7	75 min
Bottom (%)	95.5	75 min
Engine Feed Sys Internal Leak Checks		
LOX Prevlv & Chilldown Shutoff Vlv Seat & Chilldown Return Check Vlv Lkg (scim)	105.0	*
LOX Chilldown Ret Check Vlv Rev Lkg (scim)	0.0	350 max
LOX Prevlv & Chilldown Shutoff Vlv Combined Seat Leakage (scim)	105.0	150 max
LOX Bleed Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	3.75	*
LOX Bleed Vlv Seat Leakage (scim)	3.75	300 max
Main Oxidizer Vlv Seat Leakage (scim)	0.0	10 max
LOX Tank & Engine Feed System Leak Checks		
LOX Low Pressure Duct Pressure (psig)	14.5	30 max
Oxidizer Pump Speed Pickup Seat Bleed (scim)	0.0	0
LOX Turbopump Torque Checks		
Pump Primary Seal Leakage:		
Max (scim)	148.0	350 max
Min (scim)	92.0	350 max
Turbine Torque:		
Breakaway (in/lbs)	13.0	1000 max
Running (in/lbs)	40.0	200 max

* Limits Not Specified

† FARR 500-226-374

4.3.2.1 (Continued)

Function	Measurement	Limits
LOX Chilldown Pump Purge Flow Checks		
Pump Purge Shutoff Sol Vlv Leakage (scim)	0.0	1 max
Pump Purge Bypass Flow (scim)	9.7	10 + 2
Pump Purge Flow (scim)	52.0†	33 to 49
Pump Purge Dump Sol Seat Leakage (scim)	0.0	0
Pump Shaft Seal Leakage (scim) (Tank Pressurized & Purge On)	3.0	*
Pump Shaft Seal Lkg - Pump Direction (scim)	0.0	75 max
Pump Shaft Seal Lkg - Tank Direction (scim)	3.0	25 max
LOX Boiloff Valve Flow Check		
Valve Seat Leakage (scim)	0.0	10 max
LOX Valves Checks		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0.0	10 max
Closed Position (scim)	0.0	10 max
Internal Closed Pos (scim)	0.0	75 max
F&D Vlv Seat Leakage (scim)	0.0	18 max
F&D Vlv Primary Shaft Seal Lkg (scim)	0.0	6.1 max
LOX Umbilical & Main Fill & Replenish Vlv Seat Leak Checks		
LOX Main Fill, Replenish, & Fill & Drain Vlvs Seat Leakage (scim)	0.0	*
LOX Main Fill & Replenish Vlvs Seat Lkg (scim)	0.0	*
O_2H_2 Burner LOX System Leak Check		
Burner LOX Prop Valve Seat Lkg (scim)	0.0	0.7 max
Burner LOX Shutdown Vlv Seat Lkg (scim)	0.0	*

LH_2 Tank, O_2H_2 Burner & Engine Feed System Leak Checks

Function	Measurement	Limits
LH_2 Tank Helium Content		
Top (%)	99.4	75 min
Bottom (%)	87.1	75 min
Engine Feed System Internal Leak Checks		
LH_2 Prevlv & Chilldown Shutoff Vlv & C/D Return Check Vlv Rev Lkg (scim)	14.6	*
LH_2 C/D Ret Check Vlv Rev Lkg (scim)	2.3	350 max
LH_2 Prevlv & C/D Shutoff Vlv Combined Seal Leakage (scim)	12.3	150 max
LH_2 Bleed Vlv & C/D Return Check Vlv Rev Leakage (scim)	2.15	*
LH_2 Bleed Vlv Seat Leakage (scim)	0.15	300 max
MOV & MFV Combined Seat Leakage (scim)	0.0	*
Main Fuel Vlv Seat Leakage (scim)	0.0	10 max

* Limits Not Specified

† FARR 500-226-374

4.3.2.1 (Continued)

Function	Measurement	Limits
Engine Purge System Leak Checks		
LH_2 Pump Drain Check Vlv Rev Lkg (scim)	3.3	25 max
LH_2 Pump Drain Check Vlv Fwd Flow 30 psi (scim)	0.0	30 max
LH_2 Pump Drain Check Vlv Fwd Flow 60 psi (scim)	3250.0	2420 min
LH_2 Pump Purge Check Vlv Rev Lkg (scim)	0.0	25 max
LH_2 Pump Intermediate Seal Lkg (scim)	10.5	500 max
LH_2 Turbine Seal Cavity Prg Check Vlv Rev Leakage (scim)	0.0	25 max
LOX Turbine Seal Cavity Prg Check Vlv Rev Leakage (scim)	0.0	25 max
LH_2 Tank & Engine Feed System Leak Checks		
LH_2 Low Pressure Duct Pressure (psig)	29.0	30 max
LH_2 Pump Speed Monitor Seal Bleed (scim)	0.0	0
LH_2 Turbopump Torque Checks		
LH_2 Pump Primary Seal Leakage:		
Max (scim)	4.0	350 max
Min (scim)	3.0	350 max
Turbine Torque:		
Breakaway (in/lbs)	30.0	1000 max
Running (in/lbs)	25.0	300 max
LH_2 Valves Leak Checks		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0.0	10 max
Closed Position (scim)	0.0	10 max
Fill & Drain Valve Seat Leakage (scim)	0.0	18 max
LH_2 Fill & Drain Vlv Primary Shaft Seal Leakage (scim)	0.0	6.1 max
LH_2 Umbilical & Main Fill & Replenish Valve Seat Leak Checks		
LH_2 Main Fill, Replenish, & Fill & Drain Valves Seat Leakage (scim)	0.0	*
LH_2 Main Fill & Replenish Valves Seat Leakage (scim)	0.0	*
O_2H_2 Burner LH_2 System Leak Check		
Combined Burner LH_2 Prop Vlv & LOX S/D Vlv Seat Leakage (scim)	0.0	*
Burner LH_2 Prop Valve Seat Leakage (scim)	0.0	0.7 max
LOX Prop Line Relief Valve Seat Lkg (scim)	0.0	0
LOX S/D Vlv Act Bellows Leakage (scim)	0.0	0

* Limits Not Specified

4.3.2.1 (Continued)

Engine GG & Exhaust System Leak Checks

Function	Measurement	Limits
Engine Seal Leak Checks		
GG Fuel Purge Check Vlv Rev Lkg (scim)	0.0	25 max
LH_2 Turbine Seal Leakage (scim)	3450.0	6450 max
2nd E&M Value from J-2 Eng Log Book (scim)	1400.0	*
LOX Turbine Seal Leakage (scim)	15.0	350 max
Start Tnk Disch Vlv Gate Seal Leakage (scim)	9.0	20 max
GG & Exhaust System Leak Checks		
Oxid Turb Bypass Vlv Shaft Seal Lkg (scim)	0.0	15 max
Oxid Manifold Carr Flng Bleed (scim)	0.0	20 max
GG LOX Poppet Rev Leakage (scim)	384.0	*
GG LOX Purge Check Vlv Rev Lkg (scim)	0.0	15 max
Hydraulic Pump Shaft Seal Lkg (scim	0.0	228 max
GG LOX & LH_2 Propellant Valve Seal Leak Checks		
GG LOX Prop Vlv Seat & Oxid Pump Shaft Seal Leakage (scim)	0.0	20 max
Combined GG LOX & LH_2 Prop Vlv Seat Lkg (scim)	0.0	*
GG LH_2 Prop Vlv Seat & Fuel Pump Shaft Seal Leakage (scim)	0.0	15 max

Engine Pump Purge Leak Checks

Function	Measurement	Limits
Pump Purge Module Internal Leak Checks		
Purge Valve Seat Leakage (scim)	0.0	12 max
Purge Discharge Pressure (psig)	88.0	67 to 110
Pump Purge Flow Checks		
GG Fuel Purge Flow (scim)	3250.0	2400 min
LOX Turbine Seal Purge Flow (scim)	3250.0	2400 min
LH_2 Turbine Seal Purge Flow (scim)	325.0	2400 min
Fuel Pump Seal Cavity Purge Flow (scim)	1000.0	200 min

Engine Pneumatics Leak Checks

Function	Measurement	Limits
Helium Control Solenoid Energized Leak Checks		
Low Press Relief Vlv Seal Leakage (scim)	0.0	5 max
Low Press Relief Vlv Pilot Bleed Lkg (scim)	0.0	10 max
Fast Shutdown Vent Port Diaph Leakage (scim)	0.0	5 max
Press Act Purge Vlv Diaph Leakage (scim)	0.0	3 max
Int Pneu Sys Leakage (He Cont Sol On) (scim)	7.0	20 max

* Limits Not Specified

4.3.2.1 (Continued)

Function	Measurement	Limits
LOX Pump Intermediate Seal Purge Leak Checks		
Seal Leakage Pump Direction (scim)	0.0	*
Seal Leakage Turbine Direction (scim)	40.0	*
Seal Leakage Total (scim)	40.0	850 max
Seal Purge Check Vlv Overboard Flow (scim)	2450.0	*
Seal Purge Flow (scim)	2490.0	1300 to 3500
Ignition Phase Solenoid Energized Leak Checks		
Start Tnk Disch Vlv 4-Way Sol Seat Lkg (scim)	6.0	15 max
Internal Pneu Sys Lkg (Ign Phase Sol On) (scim)	6.0	20 max
Start Tank Discharge Valve Solenoid Energized Leak Checks		
STDV 4-Way Sol Seat Lkg (Energized) (scim)	2.2	15 max
Mainstage Control Solenoid Energized Leak Check		
Press Act Fast Shutdown Vlv Seat Lkg (scim)	0.0	10 max
Int Pneu Sys Lkg (Mnstg Sol ON) (scim)	12.0	20 max
Pressure Actuated Purge System Leak Check		
Press Act Purge Vlv Vent Seat Lkg (scim)	0.0	10 max
Press Act Purge Vlv Inlet Seat Lkg (scim)	0.0	10 max
Engine Control Bottle Fill System Leak Check		
Eng Cont Bot Fill Check Vlv Rev Lkg (scim)	0.0	3 max
Eng Cont Bot Decay Check (Delta M) (lb-mass/hr)	0.001	0.036 max

LOX & LH_2 Vent System Leak Checks

Function	Measurement	Limits
LOX Vent System Leak Checks		
Combined LOX Vent & Relief Vlv & Relief Vlv Seat & Pilot Bleed Lkg (scim)	45.0	100 max
Combined LOX V&R Vlv & Relief Vlv Seat, Pilot Bleed Lkg (scim)	272.0	*
LOX Vent Boost Piston Seal Lkg (scim)	227.0	2420 max
LOX Vent Valve Open Act Seal Lkg (scim)	0.0	75 max
Propulsive Vent System Leak Checks		
Cont Vent & Orifice Bypass Vlv Seat Lkg (scim)	0.0	16 max
Nonpropulsive Vent System Leak Checks		
Bidirect Vent Vlv Act Seal & Blade Shaft Seal Lkg - Flight Pos (scim)	0.0	3.5 max
Bidirect Vent Vlv Seat Lkg (Flt Pos) (scim)	0.0	50 max
Bidirect Vent Vlv Act Seal & Blade Shaft Seal Leakage - Ground Pos (scim)	0.0	3.5 max

* Limits Not Specified

4.3.2.1 (Continued)

Function	Measurement	Limits
Ground Vent System Leak Checks		
Combined LH_2 V&R Vlv, Relief Vlv Seat, & Pilot Bleed Lkg (scim)	0.0	150 max
Combined LH_2 V&R Vlv & Relief Vlv Seat, Pilot Bleed, & Boost Piston Seal Lkg (scim)	100.0	*
LH_2 V&R Vlv Boost Piston Seal Lkg (scim)	100.0	1725 max
LH_2 Vent Valve Open Act Seal Lkg (scim)	0.0	75 max
Bidirect Vent Vlv Seat Lkg (Gnd Pos) (scim)	0.0	50 max
Bidirect Vent Vlv Act Piston Lkg:		
Ground Position (scim)	0	3 max
Flight Position (scim)	0	3 max

4.3.3 Forward Skirt Thermoconditioning System Checkout Procedure (1B41955 C)

The forward skirt thermoconditioning system (TCS), P/N 1B38426-513, was functionally checked per this manual procedure to prepare it for operation and to verify that the system was capable of supporting stage poststorage checkout operations. The checkout utilized the TCS servicer, P/N 1A78829-1, which conditioned and supplied the water/methanol heat transfer fluid to the TCS.

Checkout of the TCS was accomplished on 8 and 9 April 1968, and was certified as acceptable on 10 April 1968. Preliminary operations included setup and connection of the servicer to the TCS and inspection of the TCS panels for open equipment mounting bolt holes and properly torqued bolts.

The TCS was pressurized to 32 ±1 psig with freon gas and leak checked with the gaseous leak detector, P/N 1B37134-1. Areas checked for leakage included all TCS B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold bellows. No leakage was detected.

The TCS was purged with gaseous nitrogen, and then water/methanol fluid was circulated through the system. Water/methanol samples were taken from the fluid sample pressure valve (system inlet) and the fluid sample return valve (system outlet), and checked for cleanliness, specific gravity, and temperature. Particle counts for each micron range were well within the acceptable cleanliness limits specified. The system inlet sample had 4 particles in the 175-700 micron range (25 allowed), and no particles in either the 700-2500 micron range or above 2500 microns (none allowed). The system return sample had 3 particles in the 175-700 micron range, and none in the other micron ranges. The specific

4.3.3 (Continued)

gravity and temperature of the fluid were measured with a hydrometer and thermometer, respectively, determining that the water/methanol concentration was within the acceptable mixture range (delta P testing band).

A differential pressure test was conducted to verify correct system geometry and proper flow distribution. The test was conducted by measuring the differential pressure between the TCS inlet and outlet, plus the inlet and outlet temperatures, while maintaining a water/methanol flow rate of 7.8 $\pm$0.2 gpm. The differential pressure was recorded as 15.9 psi, while inlet and outlet temperatures were recorded at 60°F and 62°F, respectively. During this checkout, operation of the TCS was conducted with the servicer at the required temperatures, pressures, and flow rate while visually checking for water/methanol leakage at all water lines, internal piping, and supply and return lines to the TCS. No leakage was detected.

This procedure demonstrated that the system was prepared to support poststorage checkout activities on the test stand. There were no discrepancies recorded against the TCS as a result of this test, nor were any revisions made to the procedure.

4.3.4 Stage and GSE Manual Controls Check (1B70177 F)

This post storage procedure verified manual control capability for the pneumatic regulators and valves in the propulsion GSE and stage systems. The test consisted of supplying electrical and/or pneumatic signals to system components and checking for proper response utilizing the Beta I Test Control Center (TCC) panels.

The manual controls checkout was initiated on 8 April 1968, and was completed on 11 April 1968. Preliminary GSE setup operations were initiated to verify that the switches and valves on the test consoles were positioned properly for the functional check. The GSE manual controls were then operated to ensure their functional capability.

The stage control helium regulator and control sphere dump valve functions were checked out with the control helium sphere pressurized to 100 ±25 psig. Then sphere pressure was increased to obtain a stabilized control helium regulator discharge pressure of 500 ±50 psig in preparation for the stage valves control check.

The stage valves control check was accomplished by supplying signals manually from the Beta I TCC control panels to the stage valve controls in a specified sequence, and then verifying correct talkback. In addition, test stand personnel verified stage valve actuation audibly or by touch. Starting at the TCC mainstage propulsion manual control panel, the LH_2 and LOX chilldown shutoff valves and the LH_2 and LOX prevalves were individually cycled and verified. At the TCC LH_2 control panel, the LH_2 tank vent and the fill and drain valves were cycled open and closed. The LH_2 tank vent boost close and the fill and

4.3.4 (Continued)

drain boost close were also cycled. The LH_2 directional vent was cycled from flight to ground position. Using the TCC LOX control panel, the LOX tank vent and fill and drain valves were cycled open and closed. The LOX tank vent boost close and the fill and drain boost close were cycled. The cold helium shutoff valve was cycled open and closed. Valves cycled from the TCC stage supply panel included the engine control bottle dump, the cold helium bottle dump, the start tank dump, and the LOX and LH_2 repressurization dump valves. The control helium bottle fill valve was then closed.

The stage valves control check was completed at the TCC repressurization control panel by cycling the O_2H_2 burner LOX and LH_2 propellant valves, and the LOX shutdown valve.

The final portion of the procedure consisted of the LH_2 and LOX umbilical purge interlock check using the TCC LH_2 and LOX control panels.

The test was terminated by securing the test stand pneumatic systems using the Beta I TCC control panels and the test stand pneumatics consoles.

There were no FARR's resulting from this checkout. Ten revisions were recorded in the procedure as follows:

a. One revision deleted the stage control helium regulator backup pressure switch check because it was to be performed during the propulsion system test, H&CO 1B62753.

b. One revision explained a momentary loss of the prevalve closed indication while opening the chilldown shutoff valves. Actuation of the chilldown shutoff valves temporarily reduced the pneumatic supply holding the prevalves closed, permitting valve "bounce", a normal characteristic of the plumbing design.

4.3.4 (Continued)

c. Two revisions were concerned with the GSE controls check, which had no bearing on the stage hardware.

d. Six revisions involved the setup and checkout of facility valves only.

4.3.5 Cryogenic Temperature Sensor Verification (1B44471 E)

The calibration and functional capabilities of the cryogenic temperature sensors, for which the normal operating range did not include ambient temperatures, were verified by this manual procedure. The cryogenic temperature sensors, basically platinum resistance elements, changed resistance according to the Callendar-Van Dusen equation. Testing of these sensors was conducted on 8 April and 9 April 1968, with the exception of those in the newly installed LOX nonpropulsive vent (NPV) system. These were tested on 22 April 1968, after completion of the LOX NPV installation.

The test sequences consisted of sensor element resistance checks and sensor wiring continuity checks. Sensor element resistance was measured for each of the transducers at ambient room temperature, with a General Radio, Model 1652A, resistance limit bridge. Ambient temperature was measured and recorded while testing each sensor. The checkout sensor parameter table specified the resistance value at $32^{o}F$ for each sensor, and its change in resistance for each degree between $32^{o}F$ and $100^{o}F$. Using these values, the required resistance at the recorded ambient temperature was calculated and compared with the actual resistance measured to determine acceptability for each sensor. A tolerance of ± 5 per cent or ± 7 per cent of the calculated resistance (depending on sensor part number), is allowed for acceptance of the actual resistance measurements.

The check for correct sensor wiring (continuity) was accomplished by connecting a jumper wire on the adapter cable, P/N 1B64095-1, and verifying that the sensor element for each transducer was shorted out to a resistance measurement of 5 ohms or less.

4.3.5 (Continued)

There were no discrepancies or FARR's documented as a result of this checkout. One revision, recorded in the procedure, provided a suitable adapter cable arrangement for checkout of the three temperature sensors in the O_2H_2 burner voting circuits. Checkout of these sensors was a new requirement authorized by WRO's 2887 and 3431.

4.3.5.1 Test Data Table, Cryogenic Temperature Sensor Verification

Meas Number	Sensor P/N	Sensor S/N	Sensor Ref.Desig.	Temp. (°F)	Resistance (ohms) Meas.	Resistance (ohms) Limits
CO 003	1B34473-1	334	403MT686	61	5060	4947 to 5691
CO 004	1B34473-501	323	403MT687	70	1525	1441 to 1593
CO 005	1A67863-503	868	405MT612	61	530	505 to 559
CO 009	1A67863-535	1146	403MT653	62	215	202 to 224
CO 015	1A67863-509	1051	410MT603	70	1518	1441 to 1593
CO 040	1A67862-505	564	406MT613	61	1460	1395 to 1541
CO 052	1A67862-513	316	408MT612	70	5370	5038 to 5796
CO 057	1A67862-501	551	406MT606	70	547	515 to 569
CO 059	1A67862-517	51424	406MT611	70	542	515 to 569
CO 133	NA5-27215T5	13531	401(3MTT17)	72	1387	1298 to 1436
CO 134	NA5-27215T5	13535	401(3MTT16)	72	1364	1298 to 1436
CO 159	1A67863-519	785	424MT610	62	215	202 to 224
CO 161	1A67863-537	1172	404MT733	62	5160	4957 to 5703
CO 208	1A67863-503	856	405MT605	61	529	505 to 559
CO 230	1A67863-509	1088	403MT706	61	1487	1415 to 1563
CO 231	1A67863-529	1064	403MT707	61	530	505 to 559
CO 256	1B37878-501	1431	409MT646	70	1542	1441 to 1593
CO 257	1B37878-501	1418	409MT647	70	1536	1441 to 1593
CO 368	1A67862-505	561	406MT660	70	1494	1420 to 1570
CO 369	1A67862-505	566	406MT661	70	1500	1420 to 1570
CO 370	1B51648-507	59802	408MT735	70	5150	5038 to 5796
CO 371	1B51648-507	64395	408MT736	70	5100	5038 to 5796
CO 2030	1B37878-511	1275	404MT760	72	554	517 to 571
CO 2031	1B37878-511	1814	404MT761	72	553	517 to 571
*	1B37878-507	1693	403A20	62	5180	4957 to 5703
*	1B37878-507	1691	403A21	62	5160	4957 to 5703
*	1B37878-507	1692	403A22	62	5180	4957 to 5703

* NASA measurement numbers not applicable to O_2H_2 burner voting circuits.

4.3.6 Umbilical Interface Compatibility Check (1B64316 E)

Prior to connecting the forward and aft umbilical cables for automatic power on checks, this manual checkout provided the test sequences which were used to check the design specifications and the continuity of the stage umbilical wiring. Accomplished by point-to-point resistance checks of all umbilical circuits, this test ensured that the proper loads were present on all power buses, and that the control circuits for the propulsion valves and safety items on the stage were within prescribed tolerances.

This procedure was initially conducted on 9 and 10 April 1968, prior to connection of the umbilicals for poststorage test operations. Three additional issues of the procedure were required on 3 June, 5 June, and 13 June 1968, due to ejection of the umbilicals during the all systems test (AST) runs. The data presented in Test Data Table 4.3.6.1 represents resistance measurements taken during the last test on 13 June 1968.

A series of resistance measurements were made at specified test points on the GSE signal distribution unit, P/N 1A59949-1, using test point terminal 463A1A5-J43FF as the common test point for all measurements. These measurements verified that all wires and connections in the umbilical cable and stage umbilical wiring were intact and of the proper material and wire gauge, and that all resistance values and loads were within the design requirement limits. A Simpson, Model 260, multimeter was used to make the resistance measurements.

No FARR's were written that resulted from the compatibility checks. Two revisions were recorded in the procedure as follows:

4.3.6 (Continued)

a. One revision authorized changing the allowable resistance tolerance for test point A2J30-W. The original tolerance of 10 to 80 ohms was increased to 10 to 300 ohms due to an additional diode in the LOX emergency vent cable, which increases the resistance.

b. One revision noted that the allowable resistance tolerances for test points CB-8-2 and CB-9-2 had to be interchanged because the stage power was in the internal condition as a result of umbilical ejection during AST testing.

4.3.6.1. Test Data Table, Umbilical Interface Compatibility Check

Reference Designation 463A2

Test Point	Function	Meas. Ohms	Limit Ohms
A2J29-C	Cmd., Ambient Helium Sphere Dump	30	10-60
CB-8-2	Cmd., Engine Ignition Bus Power Off	5	5-100
CB-9-2	Cmd., Engine Ignition Bus Power On	Inf.	Inf.
CB-10-2	Cmd., Engine Control Bus Power Off	Inf.	Inf.
CB-11-12	Cmd., Engine Control Bus Power On	6	5-100
A2J29-N	Cmd., Engine He Emerg Vent Control On	55	10-60
A2J29-P	Cmd., Fuel Tank He Sphere Dump	40	10-60
A2J29-Y	Cmd., Start Tk Vent Pilot Valve Open	23	10-60
CB-4-2	Cmd., LOX Tank Cold He Sphere Dump	33	10-60
A2J29-c	Cmd., LOX Tank Repress He Sphere Dump	40	10-60
A2J29-h	Cmd., Fuel Tank Vent Pilot Vlv Open	230	10-300
	(Same, reverse polarity)	Inf.	500k min
A2J29-i	Cmd., Fuel Tank Vent Vlv Boost Close	70	10-80
	(Same, reverse polarity)	Inf.	500k min
A2J29-q	Cmd., Ambient He Supply Shutoff Vlv Close	26	10-60
A2J30-H	Cmd., Cold He Shutoff Vlv Close	1.2k	1.5k max
	(Same, reverse polarity)	Inf.	Inf.
A2J30-W	Cmd., LOX Vent Valve Open	200	10-300
	(Same, reverse polarity)	Inf.	500k min
A2J30-X	Cmd., LOX Vent Valve Close	70	10-80
	(Same, reverse polarity)	Inf.	500k min
A2J30-Y	Cmd., LOX and Fuel Prevlv Emergency Close	70	10-80
	(Same, reverse polarity)	Inf.	Inf.
A2J30-Z	Cmd., LOX and Fuel Chilldown Valve Close	70	10-80
	(Same, reverse polarity)	Inf.	500k min
A2J30-b	Cmd., LOX Fill & Drain Vlv Boost Close	34	10-40
A2J30-c	Cmd., LOX Fill & Drain Valve Open	34	10-40
A2J30-d	Cmd., Fuel Fill & Drain Valve Boost Close	34	10-40
A2J30-e	Cmd., Fuel Fill & Drain Valve Open	34	10-40
A2J42-F	Meas., Bus +4D111 Regulation	Inf.	100 min

4.3.6.1 (Continued)

Test Point	Function	Meas. Ohms	Limit Ohms
A2J35-y	Meas., Bus +4D141 Regulation	Inf.	50 min
A2J6-AA	Sup., 28v Bus +4D119 Talkback Power	100	60-120

Reference Designation 463A1

Test Point	Function	Meas. Ohms	Limit Ohms
A5J41-A	Meas., Bus +4D131 Regulation	Inf.	20 min
A5J41-E	Meas., Bus +4D121 Regulation	Inf.	1.6k min
A5J53-AA	Sup., 28v +4D119 Fwd Talkback Power	75	60-100

4.3.7 Auxiliary Propulsion System Interface Compatibility Checkout (1B49558 B)

Contained in this manual checkout were the test sequences necessary to verify a suitable electrical interface between the stage and the auxiliary propulsion system (APS) modules, P/N 1A83918-519, S/N's 1010-1 and 1010-2, after installation of the modules on the stage.

This checkout was satisfactorily performed and certified as acceptable on 9 April 1968. Preliminary inspection of plugs and sockets was accomplished prior to mating to ensure against damaged electrical connectors. Resistance checks verified proper connections between the stage control relay packages and the APS engine valves, and also between the stage aft skirt and the APS control system components. Refer to Test Data Table 4.3.7.1 for results of the point-to-point resistance measurements.

There were no discrepancies recorded by FARR's as a result of this checkout. Four revisions were recorded in the procedure as follows:

a. One revision corrected a procedural error that omitted a notation requiring the removal of a patch board and reinstallation of the patch board, after procedural completion.

b. One revision indicated that a preliminary out-of-tolerance resistance measurement for test point 404A4J7x to stage ground was caused by failure to connect a connector. Proper connection was made, and the repeated resistance measurement was within tolerance as listed in the Test Data Table.

c. One revision authorized changing the resistance tolerance range for the connections between the aft skirt and the APS control components to comply with the specifications of the product acceptance test requirements, 1B52663, and the S-V APS modules electrical module checkout controls and instrument interface, H&CO 1B70108.

4.3.7 (Continued)

d. One revision deleted all sections of the procedure applicable to testing with APS simulators, because the APS modules, S/N's 1010-1 and 1010-2, had been installed for poststorage checkout as required.

4.3.7.1 Test Data Table, APS Interface Compatibility

Common Test Point: Stage Ground

Stage Comp.	Test Point	APS Component	Meas. Ohms	Limit Ohms
404A51A4	J4 A	414A8L1 Eng. 1, Valve A	24	25 ± 5
404A51A4	J4 B	414A8L5 Eng. 1, Valve 1	24	25 ± 5
404A51A4	J4 C	414A8L2 Eng. 1, Valve C	24	25 ± 5
404A51A4	J4 D	414A8L6 Eng. 1, Valve 3	24	25 ± 5
404A51A4	J4 E	414A8L3 Eng. 1, Valve B	24	25 ± 5
404A51A4	J4 F	414A8L7 Eng. 1, Valve 2	24	25 ± 5
404A51A4	J4 G	414A8L4 Eng. 1, Valve D	24	25 ± 5
404A51A4	J4 H	414A8L8 Eng. 1, Valve 4	24	25 ± 5
404A51A4	J4 J	414A10L1 Eng. 3, Valve A	24	25 ± 5
404A51A4	J4 K	414A10L5 Eng. 3, Valve 1	24	25 ± 5
404A51A4	J4 L	414A10L2 Eng. 3, Valve C	25	25 ± 5
404A51A4	J4 M	414A10L6 Eng. 3, Valve 3	25	25 ± 5
404A51A4	J4 N	414A10L3 Eng. 3, Valve B	25	25 ± 5
404A51A4	J4 P	414A10L7 Eng. 3, Valve 2	24	25 ± 5
404A51A4	J4 R	414A10L4 Eng. 3, Valve D	25	25 ± 5
404A51A4	J4 S	414A10L8 Eng. 3, Valve 4	25	25 ± 5
404A51A4	J4 T	414A9L1 Eng. 2, Valve A	24	25 ± 5
404A51A4	J4 U	414A9L5 Eng. 2, Valve 1	24	25 ± 5
404A51A4	J4 V	414A9L2 Eng. 2, Valve C	25	25 ± 5
404A51A4	J4 W	414A9L6 Eng. 2, Valve 3	24	25 ± 5
404A51A4	J4 X	414A9L3 Eng. 2, Valve B	24	25 ± 5
404A51A4	J4 Y	414A9L7 Eng. 2, Valve 2	24	25 ± 5
404A51A4	J4 Z	414A9L4 Eng. 2, Valve D	24	25 ± 5
404A51A4	J4 a	414A9L8 Eng. 2, Valve 4	24	25 ± 5
404A71A19	J4 A	415A8L1 Eng. 1, Valve A	27	25 ± 5
404A71A19	J4 B	415A8L5 Eng. 1, Valve 1	27	25 ± 5
404A71A19	J4 C	415A8L2 Eng. 1, Valve C	27	25 ± 5
404A71A19	J4 D	415A8L6 Eng. 1, Valve 3	27	25 ± 5
404A71A19	J4 E	415A8L3 Eng. 1, Valve D	27	25 ± 5
404A71A19	J4 F	415A8L7 Eng. 1, Valve 2	27	25 ± 5
404A71A19	J4 G	415A8L4 Eng. 1, Valve D	27	25 ± 5
404A71A19	J4 H	415A8L8 Eng. 1, Valve 4	27	25 ± 5

4.3.7.1 (Continued)

Stage Comp.	Test Point	APS Component	Meas. Ohms	Limit Ohms
404A71A19	J4 J	414A10L1 Eng. 3, Valve A	27	25 ± 5
404A71A19	J4 K	414A10L5 Eng. 3, Valve 1	27	25 ± 5
404A71A19	J4 L	414A10L2 Eng. 3, Valve C	27	25 ± 5
404A71A19	J4 M	414A10L6 Eng. 3, Valve 3	27	25 ± 5
404A71A19	J4 N	414A10L3 Eng. 3, Valve B	27	25 ± 5
404A71A19	J4 P	414A10L7 Eng. 3, Valve 2	27	25 ± 5
404A71A19	J4 R	414A10L4 Eng. 3, Valve D	27	25 ± 5
404A71A19	J4 S	414A10L8 Eng. 3, Valve 4	27	25 ± 5
404A71A19	J4 T	415A9L1 Eng. 2, Valve A	27	25 ± 5
404A71A19	J4 U	415A9L5 Eng. 2, Valve 1	27	25 ± 5
404A71A19	J4 V	415A9L2 Eng. 2, Valve C	27	25 ± 5
404A71A19	J4 W	415A9L6 Eng. 2, Valve 3	27	25 ± 5
404A71A19	J4 X	415A9L3 Eng. 2, Valve B	27	25 ± 5
404A71A19	J4 Y	415A9L7 Eng. 2, Valve 2	27	25 ± 5
404A71A19	J4 Z	415A9L4 Eng. 2, Valve D	27	25 ± 5
404A71A19	J4 a	415A9L8 Eng. 2, Valve 4	27	25 ± 5
404A4	J7 r	414A5L1	17	15-25
404A4	J7 d	414A5L1	18	15-25
404A4	J7 p	414A6L1	17	15-25
404A4	J7 x	414A1L1	21	15-25
404A4	J7 f	414A1L1	18	15-25
404A4	J7 v	414A2L2	13	13-25
404A4	J7 m	414A6L2	16	13-25
404A4	J7 t	414A2L2	16	13-25
404A4	J7 z	SPARE	Inf.	Inf.
404A4	J7 q	415A5L1	17	13-25
404A4	J7 c	415A5L1	18	13-25
404A4	J7 n	415A6L1	17	13-25
404A4	J7 w	415A1L1	18	13-25
404A4	J7 e	415A1L1	17	13-25
404A4	J7 u	415A2L1	13	13-25
404A4	J7 k	415A6L2	17	13-25
404A4	J7 s	415A2L2	16	13-25
404A4	J7 y	SPARE	Inf.	Inf.
404A2A16	J2 B	414A7L1 Eng. 4, Valve A	40	40 ± 5
404A2A16	J2 C	414A7L2 Eng. 4, Valve 1	40	40 ± 5
404A2A16	J2 A	414A7L1 Eng. 4, Valve A	42	40 ± 5
404A2A16	J2 D	414A7L2 Eng. 4, Valve 1	41	40 ± 5

4.3.8 Stage Power Setup (1B55813 G)

Prior to initiation of automatic poststorage checkouts for the stage, the stage power setup procedure verified the capability of the GSE automatic checkout system (ACS) to control power switching to and within the stage, and ensured that the stage forward and aft power distribution system was not subjected to excessive static loads during initial setup sequences. After the procedure was successfully demonstrated, it was used to establish initial conditions during subsequent automatic poststorage procedures.

Demonstration runs for the stage power setup were conducted during poststorage operations before and after the stage cold flow evaluation test in preparation for subsequent automatic checkouts. Two runs of the stage power setup test were required before the test was satisfactorily completed prior to the cold flow evaluation test. The first run was on 11 April 1968. The second run, on 22 April 1968, was necessary to verify proper talkback of the LOX tank nonpropulsive vent closed indication, which had malfunctioned during the initial test run on 11 April 1968. For the purpose of this narrative report, the discussion and the measurements presented in Test Data Table 4.3.8.1 are limited to the final demonstration test conducted after the cold flow on 6 May 1968.

The test started by resetting all of the matrix magnetic latching relays; then, verifying that the corresponding command relays were in the proper state. Verification was made that the umbilical connectors were mated, and that the LOX and LH_2 inverters were disconnected. The bus 4D119 talkback power was turned on, and the prelaunch checkout group power was turned off. The forward power and the aft power buses were transferred to external power. The sequencer

4.3.8 (Continued)

power, engine control bus power, engine ignition bus power, APS bus 1 and bus 2 power, and propellant level sensor power were all verified to be off. The power to the range safety system 1 and 2 receivers and the EBW firing units was transferred to external and verified to be off. The switch selector checkout indication enable and the flight measurement indication enable were turned on.

The forward bus 1, 28 vdc power supply was turned on, and the forward bus 1 initial current and voltage were measured. The range safety safe and arm device was verified to be in the safe condition.

The 70 pound ullage engine relay, the LH_2 continuous vent valve relay, the LH_2 and LOX repressurization mode relay, the LOX repressurization control valve relay, and the O_2H_2 burner propellant valve relay were reset. The LH_2 continuous vent and relief overboard valve was verified to be closed.

The propellant utilization boiloff bias was turned off. The O_2H_2 burner spark systems 1 and 2 voltages were measured and recorded. It was verified that the O_2H_2 burner LOX valve, LOX shutdown valve, LH_2 valve, and the LH_2 continuous vent orificed bypass valve were closed.

The forward bus 1 quiescent current was measured. The PCM system group was turned on, and the amperage of the PCM system group was measured. The forward bus 2, 28 vdc power supply was turned on, and the forward bus 2 current and voltage were measured. The forward 2 local sensor was verified to be off.

The prelaunch checkout group power was turned on, and the current was measured. The DDAS ground station source selector switch was manually set to position 1,

4.3.8 (Continued)

and it was verified that the ground station was in sync. The EBW pulse sensor power was turned off.

The cold helium supply shutoff valve was closed. The aft bus 1, 28 vdc power supply was turned on, and the aft 1 power supply current and voltage were measured. The aft 1 local sensor and the EBW pulse sensor were verified to be off. Sequencer power was then turned on and its current was measured. The forward and aft battery load tests were turned off and verified to be off.

A series of checks then verified that stage functions were in the proper state. Forty functions were verified to be off, and twenty-three functions were verified to be on. The LOX and LH_2 prevalves and chilldown shutoff valves were verified to be open, and the LOX and LH_2 vent valves and fill and drain valves were verified to be closed. The final operations measured the forward and aft 5 volt excitation module voltages, the range safety EBW firing unit charging voltages, the aft bus 2 voltage, the forward and aft battery simulator voltages, and the component test power voltage.

All measurements taken were within tolerance. There were no significant problems encountered during the test, and no FARR's were initiated.

Six revisions were recorded in the procedure for the following:

a. Three revisions corrected program errors.

b. One revision authorized changes in the program to compensate for the inability of the external power supplies to properly regulate voltage when switching from local to remote sense. A proposed solution, per ECP 7848-R2, to install filters on the power supply remote sense lines, had not been accomplished.

4.3.8 (Continued)

c. One revision authorized deletion of the period counter echo checks due to inability to comply with the executive program without additional wiring in the response conditioner.

d. One revision authorized changing the 2 second flip-flop sense code in the computer interface unit to incorporate the manual control detection and ground instrumentation system interface control modification.

4.3.8.1 Test Data Table, Stage Power Setup

Function	Measured Value	Limits
Forward Bus 1 Power Supply Current (amps)	6.000	20 max
Bus 4D31 Forward 1 Voltage (vdc)	28.158	28 ± 0.5
O_2H_2 Burner Spark System 1 Voltage (vdc)	0.000	0 ± 0.5
O_2H_2 Burner Spark System 2 Voltage (vdc)	0.000	0 ± 0.5
Forward Bus 1 Quiescent Current (amps)	0.300	5 max
PCM System Group Current (amps)	6.399	5 ± 3
Forward Bus 2 Power Supply Current (amps)	0.500	2 max
Bus 4D21 Forward 2 Voltage (vdc)	28.399	28 ± 0.5
Prelaunch Checkout Group Current (amps)	1.600	1 ± 3
Aft 1 Power Supply Current (amps)	0.300	2 max
Bus 4D11 Aft 1 Voltage (vdc)	28.039	28 ± 0.5
Sequencer Power (amps)	0.700	0 ± 3
Aft 5v Excitation Module Voltage (vdc)	4.994	5.00 ± 0.030
Fwd 1, 5v Excitation Module Voltage (vdc)	5.014	5.00 ± 0.030
Fwd 2, 5v Excitation Module Voltage (vdc)	4.997	5.00 ± 0.030
Range Safety 1 EBW Firing Unit Chg Voltage (vdc)	0.000	0 ± 1
Range Safety 2 EBW Firing Unit Chg Voltage (vdc)	0.000	0 ± 1
Bus 4D41 Aft Bus 2 Voltage (vdc)	0.000	0 ± 1
Bus 4D30 Fwd Battery 1 Voltage (vdc)	0.000	0 ± 1
Bus 4D20 Fwd Battery 2 Voltage (vdc)	0.000	0 ± 1
Bus 4D10 Aft Battery 1 Voltage (vdc)	-0.039	0 ± 1
Bus 4D40 Aft Battery 2 Voltage (vdc)	0.000	0 ± 1
Component Test Power Voltage (vdc)	0.560	0 ± 1

4.3.9 Stage Power Turnoff (1B55814 F)

The stage power turnoff procedure was used for the automatic shutdown of the stage power distribution system to return the stage to the de-energized condition upon completion of the various stage poststorage system checkout procedures. The procedure deactivated stage relays so that no current flowed from the battery simulators through the stage wiring. All internal/external transfer relays were set to the external condition.

Demonstration runs for the stage power turnoff were conducted during poststorage operations on 11 April and 6 May 1968, before and after, respectively, the stage cold flow evaluation test. After successful demonstration, each procedure was used for automatic power turnoff following the completion of the subsequent automatic checkouts. Since the intent of this report is to present the most current data, the discussion that follows and the measurements presented in Test Data Table 4.3.9.1 are limited to the final demonstration run on 6 May 1968.

The automatic stage power turnoff was started by verifying that the umbilical connectors were mated, and that the flight measurement indication enable command was turned on. The bus 4D119 talkback power, the forward bus 1 and aft bus 1, 28 vdc power supplies, and the sequencer power were all verified to be on. The forward bus 1 and aft bus 1 voltages were then measured.

The switch selector functions were then turned off, and a series of checks verified that the stage electrical functions were in the proper state of off or reset. The O_2H_2 burner spark system 1 and 2 voltages were measured. The forward and aft bus power supplies were verified to be off, and the forward

4.3.9 (Continued)

and aft bus battery simulator voltages were measured. The stage buses were then transferred to external power, and the forward and aft stage bus voltages were measured. The EBW pulse sensor power was turned off, and the range safety receivers and the EBW firing units were transferred to external power. The range safety system safe and arm device was verified to be on safe, and the bus 4D119 talkback power was turned off. The matrix magnetic latching relays were then reset; thus, completing this demonstration run for stage power turnoff.

There were no FARR's written against this test. No problems were noted and no revisions were recorded in the procedure.

4.3.9.1 Test Data Table, Stage Power Turnoff

Function	Measured Value	Limits
Forward Bus 1 Voltage Power On (vdc)	27.999	28 ± 2
Aft Bus 1 Voltage Power On (vdc)	28.039	28 ± 2
O_2H_2 Burner Spark System 1 Voltage (vdc)	-0.079	0 ± 0.5
O_2H_2 Burner Spark System 2 Voltage (vdc)	0.000	0 ± 0.5
Forward Bus 1 Battery Simulator Voltage (vdc)	-0.039	0 ± 1
Forward Bus 2 Battery Simulator Voltage (vdc)	0.000	0 ± 1
Aft Bus 1 Battery Simulator Voltage (vdc)	-0.039	0 ± 1
Aft Bus 2 Battery Simulator Voltage (vdc)	-0.079	0 ± 1
Forward Bus 1 Voltage Power Off (vdc)	0.000	0 ± 1.0
Forward Bus 2 Voltage Power Off (vdc)	0.079	0 ± 1.0
Aft Bus 1 Voltage Power Off (vdc)	0.000	0 ± 1.0
Aft Bus 2 Voltage Power Off (vdc)	0.000	0 ± 1.0

4.3.10 Digital Data Acquisition System Calibration (1B55816 F)

This procedure provided the manual and automatic operations for the checkout and calibration of the digital data acquisition system (DDAS) and prepared the system for use. The integrity of the DDAS was verified from data inputs through the various multiplexers and the PCM/DDAS assembly to the DDAS ground station. The items involved in this test were the PCM/DDAS assembly, P/N 1B65792-1, S/N 6700092, which replaced P/N 1A74049-511, S/N 016, reference FARR A270665; the CP1-B0 time division multiplexer, P/N 1B62513-547, S/N 013; the DP1-B0 time division multiplexer, P/N 1B62513-543, S/N 014; the remote digital submultiplexer (RDSM), P/N 1B52894-501, S/N 025; and the low level remote analog submultiplexer (RASM), P/N 1B66050-501, S/N 08, which replaced P/N 1B54062-505, S/N 040, reference FARR 500-226-366.

Three issues of this procedure were required to satisfactorily complete post-storage calibration of the DDAS. The first test was successfully accomplished on 17 April 1968; however, a second test was conducted on 7 May 1968, because of the previously noted PCM/DDAS replacement during stage power setup on 30 April 1968. The third and final test on 27 May 1968, was required to checkout the new RASM noted above, a replacement made necessary during the DDAS automatic system test on 27 May 1968. Only those portions of the second and third issues of the procedure necessary to verify the replacement hardware were performed. Variable data quoted in the body of this narrative was taken from the final test of the hardware concerned, unless noted otherwise.

The stage power was turned on per H&CO 1B55813, and initial conditions were established for the stage and DDAS. The 72 kHz bit rate check was made on the

4.3.10 (Continued)

PCM data train to ensure that the frequency was within tolerance. The 72 kHz bit rate was measured as 72,004 bits per second, well within the 71,975 to 72,025 bits per second limits. The 600 kHz VCO test was accomplished by measuring the band edge frequencies and voltages of the PCM/DDAS VCO output. The upper band edge frequency was measured at 633.34 kHz at 2.90 vrms, within the acceptable limits of 623.2 kHz to 642.2 kHz, at greater than 2.2 vrms. The lower band edge frequency was measured at 567.50 kHz at 2.91 vrms, within the acceptable limits of 556.8 kHz to 576.8 kHz, at greater than 2.2 vrms. The frequency differential was calculated as 65.84 kHz, within the acceptable limits of 60 to 80 kHz.

The next tests performed were the flight calibration and individual checks of the CP1-B0 and DP1-B0 multiplexers. The outputs of the multiplexer data channels were recorded for each of the calibration and input levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc. All measured channels were within the required tolerances.

The RDSM was verified by inserting signal levels equivalent to ones (20 vdc) and zeros (0 vdc) into the RDSM input circuits and by checking the output at the computer for a digital word of corresponding ones and zeros. The RASM was verified by inserting signal voltages, 0 to 30 millivolts, which were amplified to an output range of 0 to 5 volts, corresponding to the 0 to 30 millivolt range input. All measured outputs for the RDSM and the RASM were within the required tolerances.

A final test measured the PCM/FM transmitter current as 4.7 amperes, within the 4.5 ± 3.0 amperes limits.

4.3.10 (Continued)

Only one discrepancy was documented by a FARR tag for DDAS calibration testing. During the final test on 27 May 1968, a noise problem existed on the 5 vdc level of the DP1-BO multiplexer, P/N 1B62513-543, S/N 014.

FARR A261659 documented this inflight calibration failure for channel DP1-BO-29-09. The value measured was 4.964 vdc, the expected tolerance was 5.000 ±0.030 vdc. The low reading was attributed to interfering signals (noise) imposed due to grounding and wire routing and was dispositioned as acceptable to Engineering. This portion of the test was repeated with the multiplexer input at 1.250 vdc without experiencing a malfunction.

Seven revisions were recorded in the procedure for issue one, eight revisions for issue two, and five revisions for issue three.

Issue one revisions were as follows:

a. One revision substituted a battery and variable resistors for the specified power supply in a test setup to eliminate variations encountered during previous testing with the power supply.

b. One revision corrected an error in test cable connections specified by a test setup schematic.

c. One revision deleted the Model DSV-4B-232 telemetry console from the end item requirements list, as it no longer exists in the Beta test area.

d. Two revisions explained malfunctions that occurred during initial conditions scan, because the O_2H_2 burner LOX shutdown valve and the LOX nonpropulsive vent valve were not installed during this test. These valves were not required for DDAS calibration.

e. One revision, for the preliminary stage power setup, revised the tolerances on the 28 vdc external power supplies from ±0.5 to ±2.0 vdc, due to lack of filters on the power supply remote sense lines required for close tolerance voltage regulation.

4.3.10 (Continued)

f. One revision attributed malfunction indications during the test to an improper ground in the test setup. The ground problem was corrected, and the affected portion of the test was satisfactorily repeated.

Issue two revisions were as follows:

a. Two revisions repeated revisions "c" and "e" of issue one.

b. One revision deleted portions of the program not required to test the new PCM/DDAS assembly, the objective of issue two.

c. One revision was a convenience change to facilitate the simultaneous engine leak check. This change has no effect on the DDAS calibration test.

d. Two revisions corrected program errors.

e. One revision deleted the period counter echo checks in the program because the response conditioner was not wired to comply with this checkout.

f. One revision changed the 2-second flip-flop sense code in the computer interface unit to incorporate the manual control detection and ground instrumentation system interface control modification.

Issue three revisions were as follows:

a. One revision deleted those portions of the program not required to test the new RASM.

b. Three revisions were identical to those previously described for issue one, revisions "a", "b", and "c".

c. One revision discussed the "noise" problem resulting in the out-of-tolerance measurement for channel DP1-B0-29-09, documented on FARR A261659 and discussed previously in this narrative report.

4.3.11 Power Distribution System (1B55815 G)

The automatic checkout of the stage power distribution system, during post-storage operation, verified the capability of the GSE to control power switching to and within the stage, and determined that initial static loads within the stage were not excessive. The procedure verified that particular stage relays were energized or de-energized, as required, and that bi-level talkback indications were received at the GSE. Static loading of the various stage systems was determined by measuring the GSE supply current before and after turn-on of each system.

The power distribution system test was conducted twice during poststorage operations on 18 April and 8 May 1968, before and after the stage cold flow evaluation test. The discussion that follows and the measurements listed in Test Data Table 4.3.11.1 are limited to the final test on 8 May 1968.

The initial conditions scan was conducted per the stage power setup H&CO, 1B55813, and initial conditions were established for the test. Starting with engine control bus power turn-on, the current differential for the aft 1 power supply was measured. The engine control bus voltage M6 was measured and determined to be within tolerance. The APS bus power was turned on, and again the current differential for the aft 1 power supply was measured. This operation was repeated for the engine ignition bus, measuring aft 1 power supply current differential and engine control bus voltage M7. The engine ignition bus power and APS bus power were then turned off and verified.

4.3.11 (Continued)

The engine safety cutoff system (ESCS) power was turned on, and the aft 1 power supply current measured. The component test power was turned on, and the aft 1 power supply current differential and component test power voltage were measured. The component test power was turned off and verified to be off by measurement of the voltage. ESCS power was then turned off.

To check the emergency detection system (EDS), verification was made that the EDS 2 engine cutoff signal turned off the engine control bus power, prevented it from being turned back on, and also turned on the instrument unit (IU) range safety 1 EBW firing unit arm and engine cutoff signal. The engine control bus voltage was measured during this check and again after the check with the bus turned back on. Verification was made that the EDS 1 engine cutoff signal turned on the nonprogrammed engine cutoff signal and the AO multiplexer engine cutoff signal indication (K13). With the EDS 1 engine cutoff signal turned off, the engine ready bypass on turned off both the nonprogrammed engine cutoff signal and the AO multiplexer engine cutoff signal indications.

The propellant point level sensor test was started by turning on the propellant level sensor power and measuring the resulting current differential for the forward 1 power supply. Next, each of the four LH_2 tank and four LOX tank point level sensors was verified to respond to simulated wet condition on commands within the allowable 300 milliseconds tolerance. A series of checks verified that a dry condition indication from any two point level sensors in either tank, obtained by simulated wet condition off commands,

4.3.11 (Continued)

resulted in the required engine cutoff signal. For the dry condition of LOX tank point level sensors 1 and 2, the LOX depletion engine cutoff timer value was measured to determine engine cutoff signal delay time. Each of the point level sensors was verified to respond to simulated wet condition off commands within the allowable 300 milliseconds tolerance. This completed the point level sensor testing.

Verification was made that the engine cutoff command turned on the AO multiplexer engine cutoff signal indication (K13), the engine cutoff indication (K140), and the engine cutoff, and that the nonprogrammed engine cutoff indication was not turned on as a result of the engine cutoff on command. With the engine cutoff command turned off, K140 was verified as off while K13 and the engine cutoff remained on until turned off by the engine ready bypass.

The propellant utilization (PU) inverter and electronics power supply current differentials were measured while power was momentarily turned on. The PCM RF assembly power was turned on, the RF group was verified to be on, the power supply differential current was measured, and the PCM RF transmitter output wattage was measured through the AO and BO multiplexers. With the telemetry RF silence command turned on, the RF group was verified to be off, the PCM RF transmitter output wattage was measured through the AO multiplexer, and the switch selector output monitor voltage (K128) was measured with the PCM RF assembly power and the switch selector read commands 1 and 2 turned on. With the telemetry RF silence command turned off, the RF group was verified to be on, and the PCM RF transmitter output wattage was again measured through the AO multiplexer.

4.3.11 (Continued)

The rate gyro voltages were manually verified to be 28.0 $\pm$2.0 vdc with gyro power turned on and 0.0 $\pm$2.0 vdc with gyro power turned off. The aft 2 power supply was verified to be within the 56.0 $\pm$1.0 vdc tolerance. Bus 4D141, 56 volt supply was turned on, the voltage was measured, and the aft 2 power supply current was measured. The aft 2 power supply local sense indication was verified to be off. The chilldown pump simulator was connected to the LOX and LH_2 chilldown inverters, and for each inverter, measurements were made of the current draw, the phase voltages, and operating frequency. The inverter voltages and frequencies were monitored and measured through hardwire and telemetry.

A series of automatic checks verified the operation of the external/internal transfer system for forward buses 1 and 2 and aft buses 1 and 2. The battery simulator voltages and the electrical support equipment load bank voltages were measured initially; then, the power bus voltages were measured with the buses transferred to internal, and the bus local sense indications were verified to be off. The bus voltages were measured again with the buses transferred back to external, and the battery simulator voltages were measured with the simulators turned off. The aft bus 2 voltage was then measured with the bus power supply turned off.

A series of checks verified that the switch selector register was operating properly, and that the instrument unit 28 vdc power supplies were on. Power was turned on to the range safety receivers after they were transferred to external power, and the resulting GSE power supply current differentials were measured. The range safety EBW firing units were verified to be on when they

4.3.11 (Continued)

were transferred to external power and momentarily turned on. This completed the power distribution test.

There were no part shortages affecting the test and no problems resulting in the initiation of FARR's. Eight revisions were recorded in the procedure as follows:

a. Four revisions authorized changes to correct program errors.

b. One revision provided for program halts to temporarily adjust the forward bus 2 voltages from the normal 28.0 $\pm$0.5 vdc to 26.5 $\pm$0.5 vdc prior to power turn-on for the PU Inverter and electronics assembly. The purpose was to protect the PUEA transistors by preventing the power turn-on surge from exceeding 30.5 vdc. The modification to correct the problem, consisting of filter circuit incorporation into the electrical power supply remote sense lines, had not been accomplished.

c. Three revisions involved malfunction indiciations and out-of-tolerance measurements that resulted from improper installation of electrical cabling. After corrections, the program portions affected were repeated successfully within tolerance and without malfunction.

4.3.11.1 Test Data Table, Power Distribution System

Function	Measurement	Limits
Engine Control Bus Current (amps)	0.300	2 ± 2
Engine Control Bus Voltage (vdc)	28.122*	Bus 4D11 ± 1
APS Bus Current (amps)	0.900	1.5 ± 3
Engine Ignition Bus Current (amps)	0.100	0 ± 2
Engine Ignition Bus Voltage, On (vdc)	28.152*	Bus 4D11 ± 1
Engine Ignition Bus Voltage, Off (vdc)	0.000	0 ± 0.45
Component Test Power Current (amps)	0.000	0 ± 2
Component Test Power Voltage, On (vdc)	28.158	28 ± 2
Component Test Power Voltage, Off (vdc)	0.560	0 ± 1
Engine Control Bus Voltage, EDS 2 On (vdc)	-0.030	0 ± 0.450
Engine Control Bus Voltage, EDS 2 Off (vdc)	28.122*	Bus 4D11 ± 1
Propellant Level Sensor Power Current (amps)	0.199	1 ± 2
LOX Depletion Engine Cutoff Timer (sec)	0.575	0.560 ± 0.025
PU Inverter & Electronics Power Current (amps)	4.600	3 ± 2
PCM RF Assembly Power Current (amps)	5.800	4.5 ± 3.0
PCM RF Transmitter Output Power, AO (watts)	22.693	10 Min.
PCM RF Transmitter Output Power, BO (watts)	22.723	10 Min.
PCM RF Transmitter Output Power, AO T/M RF Silence On (watts)	-0.118	0 ± 2
Switch Selector Output Monitor, K128 (vdc)	2.133	2 ± 0.425
PCM RF Transmitter Output Power, AO, T/M RF Silence Off (watts)	22.753	10 Min.
Aft Bus 2 Current (amps)	-0.399	5 Max.
Aft Bus 2 Voltage (vdc)	55.999	56 ± 1

Chilldown Inverter Tests

Function	LOX Inv.	LH_2 Inv.	Limits
Inverter Current (amps)	19.690	21.200	20.0 ± 5.0
Phase AB Voltage, Hardwire (vac)	56.448*	57.296*	Bus 4D41 ± 3
Phase AC Voltage, Hardwire (vac)	56.188*	55.798*	Bus 4D41 ± 3
Phase A1B1 Voltage, Hardwire (vac)	56.384*	56.253*	Bus 4D41 ± 3
Phase A1C1 Voltage, Hardwire (vac)	56.253*	55.668*	Bus 4D41 ± 3
Frequency, Hardwire (Hz)	401.000	400.000	400.0 ± 4.0
Phase AB Voltage, Telemetry (vac)	55.532*	55.398*	Bus 4D41 ± 3
Phase AC Voltage, Telemetry (vac)	55.932*	55.532*	Bus 4D41 ± 3
Frequency, Telemetry (Hz)	400.477	399.680	400.0 ± 4.0

Function	Measurement	Limits
Forward Battery 1 Simulator Voltage (vdc)	28.318	28 ± 2
Forward Battery 2 Simulator Voltage (vdc)	27.919	28 ± 2
Aft Battery 1 Simulator Voltage (vdc)	28.199	28 ± 2
Aft Battery 2 Simulator Voltage (vdc)	56.237	56 ± 4

*In Tolerance, Actual Voltage Limits Not Specified

4.3.11.1 (Continued)

Function	Measurement	Limits
Bus 4D20 ESE Load Bank (vdc)	0.000	0 ± 1
Bus 4D40 ESE Load Bank (vdc)	-0.079	0 ± 1
Bus 4D30 ESE Load Bank (vdc)	-0.039	0 ± 1
Bus 4D10 ESE Load Bank (vdc)	-0.079	0 ± 1
Forward Bus 1 Voltage-Internal (vdc)	28.278	28 ± 2
Forward Bus 2 Voltage-Internal (vdc)	27.759	28 ± 2
Aft Bus 1 Voltage-Internal (vdc)	28.239	28 ± 2
Aft Bus 1 Voltage-External (vdc)	28.158	28 ± 2
Aft Battery 1 Voltage (vdc)	-0.079	0 ± 1
Aft Bus 2 Voltage-Internal (vdc)	55.917	56 ± 4
Aft Bus 2 Voltage-External (vdc)	56.237	56 ± 4
Aft Battery 2 Voltage (vdc)	0.000	0 ± 1
Forward Bus 1 Voltage-External (vdc)	28.118	28 ± 2
Forward Battery 1 Voltage (vdc)	0.039	0 ± 1
Forward Bus 2 Voltage-External (vdc)	27.958	28 ± 2
Forward Battery 2 Voltage (vdc)	0.000	0 ± 1
Aft Bus 2 Voltage, Off (vdc)	0.000	0 ± 1
Range Safety Receiver 1 External Power Current (amps)	0.250	0 ± 2
Range Safety Receiver 2 External Power Current (amps)	1.249	0 ± 2

4.3.12 <u>Hydraulic System Setup and Operation (1B41005 B)</u>

The purpose of this manual procedure was to ensure that the hydraulic system was correctly flushed, filled, bled, and maintained free of contamination during hydraulic system operation. The hydraulic system pressure and temperatures were checked for proper operational levels, the hydraulic system transducer circuits were tested for correct operation and reponse characteristics, and the J-2 engine operational clearance in the aft skirt was established.

Checkout was initiated on 18 April 1968, prior to the stage cold flow test, held open and continued after cold flow, and completed on 3 June 1968. Proper operation of the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454588; the hydraulic actuator assemblies, P/N 1A66248-505, S/N's 51 and 53; the main hydraulic pump, P/N 1A66240-503, S/N X457808; and the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00034, was verified during checkout activity. There were no part shortages affecting this test.

Prior to operation of the stage hydraulic system, the hydraulic pumping unit (HPU), P/N 1A67443-1, was checked to ensure that the hydraulic fluid met the cleanliness requirements. The HPU was connected to the stage via the pressure and return hoses. Hydraulic fluid was circulated through the stage system to ensure that the system was properly filled, and hydraulic fluid samples were taken and were certified to be free of contamination.

The accumulator/reservoir was charged with gaseous nitrogen, and the stage air bottles were charged to a pressure of 475 $\pm$50 psig. The HPU was turned on, and the system pressure was increased until the hydraulic pressure gauge indicated no further increase in pressure and less than 4400 psig; then, the stage

4.3.12 (Continued)

hydraulic system was checked for leaks. No unacceptable system leakage was detected, and upon completion of the leak check, the stage hydraulic system pressure was reduced to 1000 $\pm$50 psig. The auxiliary hydraulic pump was turned on and verified to be operating properly.

With the midstroke locks installed on the hydraulic actuators, the vernier scales were adjusted to read zero. The pitch and yaw command relays were disabled, and the midstroke locks were removed. The HPU was turned on, and the hydraulic system pressure brought up to 3650 $\pm$50 psig. After the pitch and yaw vernier scales were read and the values were recorded in Test Data Table 4.3.12.1, the HPU was turned off, and the midstroke locks were reinstalled.

After the stage cold flow test, the engine deflection clearance check was accomplished. The gimbal control unit (GCU), P/N 1B50915, was installed and set up per H&CO 1B53382. The J-2 engine bellows protective covers were removed, and the platform extension, P/N 1B70620, was removed from the engine area. The J-2 engine restrainer and the hydraulic actuator midstroke locks were removed. After an inspection of the engine area for possible interference points, the HPU was turned on, and stage system pressure brought up to 1000 psig. The pitch and yaw controls on the GCU was turned in the retract and extend directions. As the controls were moved, it was verified that the pitch and yaw actuators moved in relation to the direction and amplitude of the controls. By returning the pitch and yaw controls to center, the actuators were positioned to center, and the HPU was turned off. The midstroke locks and the J-2 engine bellows protective covers were reinstalled.

4.3.12 (Continued)

To support poststorage operations after the stage cold flow test, verification and setup of instrumentation between the stage hydraulic system and the test control center was accomplished through the required telemetry; however, hard-wire instrumentation "patching" had been used prior to the cold flow for this purpose. The HPU was turned on, and the pressure compensator adjusted until the system hydraulic pressure indicated the desired readings. The resulting HPU, system, and accumulator GN_2 pressure parameter comparison checks are listed in Test Data Table 4.3.12.1. In addition, reservoir oil level and pressure parameters were verified, and the reservoir low level switch was checked for proper operation.

The shutdown sequence of this checkout included a final air content test which provided information necessary for system analysis by discharging a portion of the internal system fluid volume overboard. The volume discharged was determined to be a function of the fluid temperature measurement to provide space in the reservoir for fluid thermal expansion under ground operating conditions (0°F to 160°F). The HPU was turned on, and system pressure was increased to 3650 $\pm$50 psig, the bypass valve was opened, and the HPU was then turned off. Verification was made that the return pressure gauge indicated a minimum of 200 psig. The shutoff valve was cycled open and closed until return pressure was reduced to 180 $\pm$5 psig. An empty 100 ml graduate was placed under the drain port, and by cycling the reservoir drain valve open and closed, the return pressure was decreased to 80 $\pm$5 psig. The volume of fluid bled was less than the 16 ml maximum as specified per design requirements. The shutdown sequence described was first accomplished prior to the stage cold flow test

4.3.12 (Continued)

and then repeated after the cold flow to complete the poststorage checkout requirements.

The final test conducted was the pressure decay check for the stage air bottle. The air bottle was verified to be charged to 470.9 psig, well within the 475 ±50 psig limits, and the pressure and range time were recorded. After a lapse of 24 hours, the bottle pressure was remeasured and recorded at 466.6 psig.

There were no discrepancies recorded as a result of this checkout, and no FARR's were initiated. Eighteen revisions were recorded in the procedure as follows:

a. One revision authorized obtaining additional fluid cleanliness samples to ensure hydraulic system and HPU cleanliness.

b. One revision added setup requirements prior to the instrumentation support checkout, because of sequences conducted for the cold flow test.

c. One revision modified the slope of the curve, depicting temperature versus drained hydraulic fluid volume to provide for greater fluid thermal expansion due to higher ground operating temperatures.

d. One revision deleted the GCU setup prior to the cold flow test. The GCU setup was accomplished after the cold flow to permit gimbaling during the engine deflection clearance check.

e. One revision repeated the shutdown sequence prior to the stage cold flow test when a low reservoir oil level was indicated.

f. One revision repeated the shutdown sequence after the cold flow test to support the balance of poststorage checkout.

g. One revision authorized a recharge of the hydraulic system accumulator because the initial GN_2 charge did not meet the pressure requirements.

h. One revision provided instructions to verify proper operation of the auxiliary hydraulic pump coast mode thermal switch prior to the cold flow test.

4.3.12 (Continued)

i. Two revisions deleted sections concerning temperature and differential pressure transducers no longer required or installed on Saturn S-IVB stages.

j. Two revisions concerned switching instrumentation from the hardwire system to normal telemetry after the cold flow test.

k. One revision provided instructions for verification and setup of instrumentation between the stage hydraulic system and test control center, using the normal telemetry system after the cold flow test. Instrumentation had been patched through the hardwire system in support of the special cold flow test.

l. One revision repeated the verification and setup of instrumentation through the telemetry system, after correcting a program error that entered the wrong DDT curves into the executive.

m. One revision deleted the engine gimbal test for instrumentation support which is used to set up strip chart recorders for stage acceptance firing only.

n. One revision provided weekend securing instructions for the HPU.

o. One revision authorized a checkout to verify proper transducer operation for measurement D209, auxiliary hydraulic pump motor gas pressure, because of discrepancies encountered during the automatic test of the hydraulic system (refer to paragraph 4.3.21).

p. One revision deleted the final engine deflection clearance check and the simulated static firing support checkout which are required only for prefire operations.

4.3.12.1 Test Data Table, Hydraulic System Setup and Operation

Instrumentation

Test Description	Name	Location	Requirement	Actual
Actuator Position System Unpressurized	Pitch Vernier	Pitch Actuator	0 Inches	0
	Yaw Vernier	Yaw Actuator	0 Inches	0
Actuator Position System Pressurized	Pitch Vernier	Pitch Actuator	Ref. Only 0 Inches	0
	Yaw Vernier	Yaw Actuator	Ref. Only 0 Inches	0

Pressure Comparison Test

HPU Press. (psig)	System Press. (psia)	Accum. GN_2 Press. (psia)
1800	1814	2266
2200	2210	2266
2600	2600	2591
3000	2999	2984
3400	3385	3366
3500	3467	3456
3600	3569	3565
3700	3677	3663
3900	3886	3873

RCH Gauge Press. (psig)	Rsvr. Press (psia)
250	267.5
100	113.5

Reservoir Oil Level Checks

Level Checked	Measurement
100%	100.4%
0%	-0.9%

4.3.13 Propellant Utilization System Calibration (1B64368 F)

This manual calibration procedure verified the operation of the propellant utilization system and provided the necessary calibration prior to the automatic checkout of the system. For calibration purposes, the propellant utilization test set (PUT/S), P/N 1A68014-1, was used to provide varying capacitance inputs to the propellant utilization electronics assembly (PUEA) to simulate the LOX and LH_2 mass probe outputs under varying propellant load conditions. The items involved in this test included the following:

Part Name	Ref. Location	P/N	S/N
Propellant Utilization Electronic Assembly (PUEA)	411A92A6	1A59358-525	04
Static Inverter-Converter	411A92A7	1A66212-507	025
LOX Mass Probe	406A1	1A48430-511	D9
LH_2 Mass Probe	408A1	1A48431-509	D4
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511	D128
LOX Fastfill Sensor	406A205	1A68710-1	D90
LOX Fastfill Control Unit	404A72A5	1A68710-511	C16
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Sensor	411A92A24	1A68710-509	D116
LH_2 Fastfill Sensor	408A2C5	1A68710-1	D89
LH_2 Fastfill Control Unit	411A92A43	1A68710-509	D121

The first issue of the calibration procedure was accomplished on 18 and 19 April 1968. Due to the replacement of the PUEA, a second issue was accomplished on 10 June 1968, and accepted on 11 June 1968. Measurements and ratiometer settings made during the last test appear in Test Data Table 4.1.13.1.

Atmospheric conditions in the test area were measured before the calibration was started. Megohm resistance measurements were made on the LH_2 and LOX mass probe elements through connector 411W11P1 at the PUEA, using a 50 vdc megohmeter. The PUT/S was connected to the PUEA; then, the static inverter-converter and the

4.3.13 (Continued)

stage power for these units was manually turned on. The static inverter-converter voltages and operating frequency were then measured.

The PUEA bridge calibrations were conducted next. Simulated empty conditions were established with the PUT/S; the PUEA LH_2 and LOX bridge empty condition calibrations were accomplished by nulling the bridge tap voltages with the PUT/S ratiometer at settings of 0.01641 for the LH_2 bridge and 0.04132 for the LOX bridge; and then, the bridge outputs were nulled by adjusting the PUEA R2 potentiometer for the LH_2 bridge and the PUEA R1 potentiometer for the LOX bridge. Simulated full conditions were then established with the PUT/S using a C1 capacitor (LH_2) setting of 181.83 picofarads and a C2 capacitor (LOX) setting of 122.52 picofarads, and the ratiometers were set to 0.82223 for the LH_2 bridge and 0.82223 for the LOX bridge. To accomplish the PUEA LH_2 and LOX bridge full calibrations, the bridge outputs were nulled by adjusting the PUEA R4 potentiometer for the LH_2 bridge and the PUEA R3 potentiometer for the LOX bridge.

Data acquisition was verified by establishing simulated empty and full conditions with the PUT/S and by adjusting the PUT/S ratiometer to null the PUEA LH_2 and LOX bridge outputs. Bridge slew checks were conducted by establishing simulated 1/3 and 2/3 slew conditions with the PUT/S and by adjusting the PUT/S ratiometer to null the PUEA LH_2 and LOX bridge outputs for each condition.

For the reference mixture ratio (RMR) calibration, the difference between the previously determined LH_2 and LOX empty ratiometer settings, 0.02491, was multiplied by 98.4 vdc to give a V1 reference voltage of 2.451 vdc. Simulated

4.3.13 (Continued)

empty conditions were established with the PUT/S, and the PUEA residual empty bias R6 potentiometer was adjusted to null the RMR bias voltage. Simulated full conditions were then established with the PUT/S, and the PUEA residual full bias R5 potentiometer was adjusted to null the RMR bias voltage. For a fuel boiloff bias calibration, simulated boiloff conditions were established with the PUT/S using a C1 capacitor (LH_2) setting of 202.30 picofarads and a C2 capacitor (LOX) setting of 122.52 picofarads. The PUEA fuel bias R7 potentiometer was then adjusted to null the RMR bias voltage.

PUEA LH_2 and LOX bridge linearity checks were accomplished by individually setting the PUT/S C1 capacitor (LH_2) and C2 capacitor (LOX) to specific values and by adjusting the PUT/S ratiometer to null the appropriate PUEA bridge output.

For a fuel boiloff bias data acquisition check, the RMR bias voltage was measured as 2.4315 vdc under simulated empty conditions and as 9.8304 vdc under bias internal test conditions. The fuel boiloff bias voltage was the difference between these measurements, -7.3989 vdc.

The hardwire loading circuits were checked by establishing simulated full conditions with the PUT/S, setting the PUT/S ratiometer to 0.00000, and measuring the hardwire loading circuit PUEA LH_2 and LOX bridge output voltages. The LH_2 voltage was 22.760 vdc and the LOX voltage was 22.765 vdc, meeting the 23.52 $\pm$2.0 vdc requirements.

4.3.13 (Continued)

Eleven revisions were made to both issues of the procedure for the following:

a. Two revisions added the requirement for the frequency counter chassis to be grounded to the test stand.

b. Two revisions added a requirement of a DC isolation transformer with the DC megohmeter to isolate the megger from the test stand.

c. Two revisions corrected typographical errors.

d. Two revisions corrected procedural errors.

e. Two revisions deleted the requirement of recording the tap value in the LOX bridge empty calibration twice, as the value does not change.

f. One revision authorized rerunning of the checkout for parameter N63 after a 45 minute warmup of the PU inverter and electrical power. This parameter had not been setup during the signal conditioning setup procedure. The applicable portion of the signal conditioning setup was performed prior to running this revision.

4.3.13.1 Test Data Table, Propellant Utilization System Calibration

Pre-Test Atmospheric Conditions

Temperature:	78°F
Pressure:	29.93 inches of Hg
Relative Humidity:	39 percent

LH_2 Mass Probe Megohm Check - Plug 411W11P1

Function	Resistance (megohms)	Limits (megohms)
LH_2 Probe Elements, Pins G to E	Inf	1000 min
Pin G to Shield	Inf	1000 min
Pin G to Stage Ground	Inf	1000 min
Pin G Shield to Stage Ground	Inf	1000 min
Pin E to Stage Ground	Inf	1000 min

LOX Mass Probe Megohm Check - Plug 411W11P1

LOX Probe Elements, Pin A to C	Inf	1000 min
Pin C to Shield	Inf	1000 min
Pin C to Stage Ground	Inf	1000 min
Pin C Shield to Stage Ground	Inf	1000 min
Pin A to Stage Ground	Inf	1000 min

4.3.13.1 (Continued)

Static Inverter-Converter

Function	Measurement	Limits
5.0 vdc Output Voltage (vdc)	4.922	4.75 to 5.45
21.0 vdc Output Voltage (vdc)	21.045	20.00 to 22.50
28.0 vdc Output Voltage (vdc)	27.335	26.00 to 30.00
117 vdc Output Voltage (vdc)	118.16	115.00 to 122.50
115 vrms Monitor Voltage (vdc)	2.721	2.23 to 3.18
Test Point 2 Voltage (vdc)	21.169	20.00 to 22.5
V/P Excitation Voltage (vdc)	49.14	47.74 to 50.80
Operating Frequency (Hz)	400.00	394.00 to 406.00

Data Acquisition

Function	PUT/S Ratiometer	Limits
LH_2 Empty	0.00019	*
LOX Empty	0.02176	*
LH_2 Full	0.82215	*
LOX Full	0.82223	*
Bridge Slew Checks		
LH_2 1/3 Slew	0.31123	*
LH_2 2/3 Slew	0.64040	*
LOX 1/3 Slew	0.28445	*
LOX 2/3 Slew	0.57199	*

LH_2 Bridge Linearity Check

PUT/S C1 Value		
36.37 pf	0.16153	0.15963 to 0.16292
72.73 pf	0.32646	0.32487 to 0.32816
109.10 pf	0.49118	0.49011 to 0.49340
145.46 pf	0.65628	0.65535 to 0.65864
181.83 pf	0.82209	0.82059 to 0.82388

LOX Bridge Linearity Check

PUT/S C2 Value		
24.50 pf	0.18232	0.18006 to 0.18335
49.01 pf	0.34152	0.34019 to 0.34348
73.51 pf	0.50156	0.50032 to 0.50361
98.02 pf	0.66165	0.66046 to 0.66374
122.52 pf	0.82232	0.82059 to 0.82388

* Limits Not Specified

4.3.14 Propellant Utilization System (1B55823 H)

This automatic checkout procedure verified the capability of the propellant utilization system to determine and control the engine propellant flow mixture ratio to ensure simultaneous propellant depletion, and to provide propellant level information to control the fill and topping valves during LOX and LH_2 loading. This test involved all components of the stage propulsion utilization system including the propellant utilization valve in the J-2 engine and the following:

Part	Ref. Location	P/N	S/N
Propellant Utilization Electronics Assembly (PUEA)	411A92A6	1A59358-525	04
Static Inverter-Converter	411A92A7	1A66212-507	025
LOX Mass Probe	406A1	1A48430-509	D9
LH_2 Mass Probe	408A1	1A48431-505	D4
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511	D128
LOX Fast Fill Senosr	406A205	1A68710-1	D90
LOX Fast Fill Control Unit	406A72A5	1A68710-511	C16
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D116
LH_2 Fast Fill Sensor	408A2C5	1A68710-1	D89
LH_2 Fast Fill Control Unit	411A92A43	1A68710-509	D121

The procedure was performed three times during the poststorage and cold flow operations. The first issue was initiated and accomplished on 19 April 1968; the second issue, performed after the coldflow test, was initiated on 10 May 1968, and certified as acceptable on 14 May 1968. Due to the replacement of the PUEA, P/N 1A59358-525, S/N 022 with S/N 04, a third issue, requiring two attempts, was accomplished on 11 June 1968. The first attempt of the third issue was aborted due to an operator error in exercising the PU valve position. The following is a narration of the final checkout, and the data appears in Test Data Table 4.3.14.1.

4.3.14 (Continued)

After initial conditions were established, ratio values were obtained from the manual propellant utilization system calibration procedure, H&CO 1B64368, and loaded into the computer. From these ratio values, nominal test values were computed for LOX and LH_2 coarse mass voltages, fine mass voltages, and loading voltages. The PU system power test was conducted first. Power was applied to the PU inverter and electronics, then the forward bus 2 voltage and the static inverter-converter output voltages and operating frequency were measured.

The servo balance and ratio valve null test was conducted next. The ratio valve position was measured, and the LOX and LH_2 coarse and fine mass voltages were measured through the AO and BO instrumentation multiplexers.

The PU loading test followed. The LH_2 boiloff bias signal voltage was measured with the boiloff bias cutoff turned on and was verified to be 0.0 $\pm$2.5 vdc with the cutoff turned off. The GSE loading potentiometer power was turned on, and the voltage measured. Measurements were then made of the LOX and LH_2 loading potentiometer sense voltages and signal voltages. Measurements of the LOX and LH_2 loading potentiometer signal voltages were repeated after the LOX and LH_2 bridge 1/3 checkout relay commands were turned on, and again after these commands were turned off. The GSE power was turned off, and the LOX and LH_2 loading potentiometer sense voltages were again measured.

The servo balance bridge gain test was conducted next. The first attempt resulted in a malfunction printout because an operator did not remove a -1.0 vdc system error test siganl which had been applied to the PU ratio valve, causing the value to be at a minus 5 degree position. The test was repeated and successfully completed. The ratio valve position was measured, and the LOX and

4.3.14 (Continued)

LH_2 coarse and fine mass voltages were measured through the AO and BO telemetry multiplexers. The measurements were repeated with the LOX and LH_2 bridge 1/3 checkout relays on, with the bridge 2/3 checkout relays on, with the bridge 2/3 checkout relays off, and again with the bridge 1/3 checkout relays off.

The next check verified that the LOX and LH_2 tank overfill and fast fill sensors and their associated control units responded properly under ambient (dry) conditions and under simulated wet conditions of the sensors.

The valve movement test measured the ratio valve positions during the 50-second plus valve slew and the valve positions during the 50-second minus valve slew.

The next section of this procedure was the PU activate test. All measurements for this test were made through the AO and BO multiplexers. The ratio valve position was measured; then, the LOX bridge 1/3 checkout relay command was turned on, and the LOX coarse mass voltage was measured. The ratio valve position was remeasured with the PU activate switch turned on and again with it turned off. The LOX bridge 1/3 checkout relay command was turned off, then the LOX coarse mass voltage and the ratio valve position were measured. These steps were repeated using the LH_2 bridge 1/3 checkout relay, then measuring the LH_2 coarse mass voltage.

For a final test, the PU valve hardover position command was turned on, and the PU system ratio valve position was measured as -27.2 degrees with the LOX bridge 1/3 checkout relay command and the PU activate switch both on. This measurement complies with the less than -20 degrees requirement.

4.3.14 (Continued)

A total of twenty-two revisions were made to the three issues of the checkout for the following:

a. Seven revisions were written to correct errors in the procedure.

b. Three revisions concerned changing the tolerance of the PU oven monitor voltage from ± 0.3 vdc to ± 0.075 vdc per ECP 2330-R2.

c. Two revisions explained that the failure of the LH_2 continuous vent valve closed talkback, not being received during the initial condition scan, was due to the continuous vent electrical preparation procedure. The cables were reconnected prior to the start of the second attempt.

d. One revision explained that the out-of-tolerance reading for the PU valve position signal was due to noise spikes occurring when the PU electronics assembly was turned on. The PU valve system was unaffected by this noise.

e. One revision explained that an error code printout statement was due to an error in the program.

f. One revision stated that the out-of-tolerance indication for the PU boiloff bias voltage was due to an improper curve on the data description tape. The tape was corrected, and the program continued with no malfunctions.

g. One revision provided instructions for a program change made to prevent the forward bus 2 power supply from over regulating when the PU inverter and electronics assembly turned on.

h. One revision changed the time cell loading data from octal to base 10 value, to be compatible with the time cell data format.

i. One revision authorized a series of tests to verify the correct operation of all measurements that were disconnected during installation of the PU assembly.

j. One revision authorized the rerunning of the entire procedure due to an indicated malfunction of the PU ratio valve position voltage. The malfunction was caused by a -1 vdc system error test signal which was present at the time of the voltage check.

k. One revision outlined a special measurement of the system test error signal voltage, per a request of the customer.

4.3.14 (Continued)

l. One revision authorized turning on the PCM transmitter power during the second performance of the procedure to simulate the same environmental conditions that existed when the PU ratio valve malfunction occurred.

m. One revision explained that the failure of the LH_2 overfill sensor to indicate a wet condition was due to the PCM transmitter being on. The sensor has a history of RFI sensitivity. The transmitter was turned off, and a recheck of the sensor was acceptable.

4.3.14.1 Test Data Table, Propellant Utilization System

Loaded Ratio Values (From H&CO 1B64368)

LOX Empty Ratio	0.021	LOX 1/3 Bridge Slew Ratio	0.283
LH_2 Empty Ratio	0.000	LOX 2/3 Bridge Slew Ratio	0.311
LH_2 Boiloff Bias Voltage	7.399	LH_2 1/3 Bridge Slew Ratio	0.571
LOX Wiper Ratio	0.040	LH_2 2/3 Bridge Slew Ratio	0.640
LH_2 Wiper Ratio	0.016		

Computed Coarse Mass Voltages (vdc)

LOX Empty	0.107	LH_2 Empty	0.000
LOX 1/3 Mass	1.416	LH_2 1/3 Mass	1.553
LOX 2/3 Mass	2.856	LH_2 2/3 Mass	3.198

Computed Fine Mass Voltages (vdc)

LOX Empty	4.106	LH Empty	1.563
LOX 1/3 Mass	0.249	LH 1/3 Mass	2.432
LOX 2/3 Mass	2.017	LH 2/3 Mass	4.683

Computed Loading Voltages (vdc)

LOX Empty	0.602	LH_2 Empty	0.000
LOX 1/3 Coarse Mass	7.930	LH_2 1/3 Coarse Mass	8.695

PU System Power Test

Function	Measured Value	Limits
Forward Bus 2 Voltage (vdc)	27.958	28. ± 2
Inv-Conv 115 vrms Output (vac)	114.414	115. ∓ 3.4
Inv-Conv 21 vdc Output (vdc)	21.220	21.25 ± 1.25
Inv-Conv 5 vdc Output (vdc)	4.967	4.8 ± 0.3
Inv-Conv Frequency (Hz)	400.070	400. ± 6

4.3.14.1 (Continued)

Bridge Balance and PU System Ratio Valve Null Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.010			0.000 ±1.5
LOX Coarse Mass Voltage (vdc)		0.107	0.107	0.107 ±0.1
LOX Fine Mass Voltage (vdc)		4.150	4.131	4.106 ±0.4
LH_2 Coarse Mass Voltage (vdc)		-0.005	0.000	0.000 ±0.1
LH_2 Fine Mass Voltage (vdc)		1.646	1.641	1.563 ±0.4

PU Loading Test

Function	Measured Value	Limits
LH_2 Boiloff Bias Signal Volt (vdc)	8.29	7.400 ± 1.0
GSE Power Supply Voltage (vdc)	28.519	28.0 ± 2.0

Loading Potentiometer Function	LOX Value	LH_2 Value	Limits
Sense Voltage, GSE Power On (vdc)	28.519	28.519	GSE Pwr ±0.4
Signal Voltage, Relay Commands Off (vdc)	0.492		0.602 ±0.5
		-0.055	0.0 ±0.5
Signal Voltage, 1/3 Checkout Relay Commands On (vdc)	7.684		7.930 ±2.0
		8.641	8.695 ±2.0
Signal Voltage, 1/3 Checkout Relay Command Off (vdc)	0.492		0.602 ±0.5
		0.000	0.0 ±0.5
Sense Voltage, GSE Power Off (vdc)	-0.039	-0.119	0.0 ±0.75

Servo Balance Bridge Gain Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.010			0.0 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.093	0.107	0.107 ± 0.1
LOX Fine Mass Voltage (vdc)		4.141	4.131	4.106 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0.000	-0.015	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.641	1.636	1.563 ± 0.4

1/3 Checkout Relay Commands On

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.487			0.0 ± 1.5
LOX Coarse Mass Voltage (vdc)		1.426	1.421	1.416 ± 0.1
LOX Fine Mass Voltage (vdc)		0.005	0.010	0.249 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		1.558	1.553	1.553 ± 0.1
LH_2 Fine Mass Voltage (vdc)		2.676	2.676	2.432 ± 0.4

4.3.14.1 (Continued)

Function	Measured Value	AO Multi	BO Multi	Limits
2/3 Checkout Relay Commands On				
Ratio Valve Position (deg)	0.965			0.0 ± 1.5
LOX Coarse Mass Voltage (vdc)		2.866	2.866	2.856 ± 0.1
LOX Fine Mass Voltage (vdc)		1.641	1.641	2.017 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		3.208	3.208	3.198 ± 0.1
LH_2 Fine Mass Voltage (vdc)		4.917	4.927	4.683 ± 0.4
2/3 Checkout Relay Commands Off				
Ratio Valve Position (deg)	0.556			0.0 ± 1.5
LOX Coarse Mass Voltage (vdc)		1.431	1.421	1.416 ± 0.1
LOX Fine Mass Voltage (vdc)		-0.005	0.000	0.249 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		1.553	1.553	1.553 ± 0.1
LH_2 Fine Mass Voltage (vdc)		2.676	2.671	2.432 ± 0.4
1/3 Checkout Relay Commands Off				
Ratio Valve Position (deg)	0.010			0.0 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.112	0.107	0.107 ± 0.1
LOX Fine Mass Voltage (vdc)		4.141	4.150	4.106 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		-0.005	-0.005	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.646	1.641	1.563 ± 0.4

PU Valve Movement Test

Function	Measured Value	Limits
Ratio Valve Position, AO (deg)	0.010	0.194 ± 1.50
Ratio Valve Position, BO (deg)	0.010	0.194 ± 1.50
50 Second Plus Valve Slew, AO Multiplexer		
+1 vdc System Test Valve Position Signal (vdc)	0.999	1.000 ± 0.030
V1, Position at T+3 Seconds (deg)	4.159	2.037 to 6.351
V2, Position at T+5 Seconds (deg)	5.250	2.659 to 7.396
V3, Position at T+8 Seconds (deg)	5.864	2.977 to 7.396
V4, Position at T+20 Seconds (deg)	6.068	5.226 to 7.396
V5, Position at T+50 Seconds (deg)	6.068	5.226 to 7.396

4.3.14.1 (Continued)

Function	Measured Value	Limits
50 Second Minus Valve Slew, AO Multiplexer		
Ratio Valve Position, AO (deg)	0.01	0.194 ± 1.50
-1 vdc System Test Valve Error Signal (vdc)	-1.020	-1.000 + 0.030
V1, Position at T+3 Seconds (deg)	-3.748	-2.037 to -6.351
V2, Position at T+5 Seconds (deg)	-4.702	-2.659 to -7.396
V3, Position at T+8 Seconds (deg)	-5.249	-2.977 to -7.396
V4, Position at T+20 Seconds (deg)	-5.521	-5.226 to -7.396
V5, Position at T+20 Seconds (deg)	-5.521	-5.226 to -7.396

PU Activation Test

Function	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	-0.125	-0.125	0.0 ± 1.5
LOX 1/3 Command Relay On			
LOX Coarse Mass Voltage (vdc)	1.415	1.426	1.421 ± 0.1
PU System On			
Ratio Valve Position (deg)	33.213	33.213	20.0 min
PU System Off			
Ratio Valve Position (deg)	0.351	0.351	15.0 max
LOX 1/3 Command Relay Off			
LOX Coarse Mass Voltage (vdc)	0.103	0.103	0.098 ± 0.1
Ratio Valve Position (deg)	0.010	0.010	0.0 ± 1.5
LH_2 1/3 Command Relay On			
LH_2 Coarse Mass Voltage (vdc)	1.548	1.558	1.543 ± 0.1
PU System On			
Ratio Valve Position (deg)	-27.465	-27.396	-20.0 max
PU System Off			
Ratio Valve Position (deg)	0.010	0.010	-15.0 min

4.3.14.1 (Continued)

Function	AO Multi	BO Multi	Limits
LH2 1/3 Command Relay Off			
Static Inv Conv 5 vdc Output (vdc)	4.960	4.962	4.8 ± 0.3
LH_2 Coarse Mass Voltage (vdc)	0.005	-0.010	0.000 ± 0.1
Ratio Valve Position (deg)	0.010	0.010	0.0 ± 1.5
PU Valve Hardover Test			
LH2 1/3 Command Relay On			
Ratio Valve Position, AO (deg)	-27.396		-20.0 max

4.3.15 Propulsion System Test (1B62752 H)

This automatic procedure performed the poststorage integrated electromechanical functional tests required to verify the operational capability of the stage propulsion system. For convenience of performance, the test sequences were divided into three sections. The first section checked the ambient helium system and included functional checks of the pneumatic control system and the propellant tanks repressurization system, the second test section checked the propellant tanks pressurization system, and the third section was a four part functional check of the J-2 engine system. The first segment of the J-2 engine checkout tested the spark ignition systems for the J-2 engine thrust chamber and gas generator, the second segment functionally checked the engine cutoff logic and delay timers, the third segment checked the J-2 engine valve sequencing with control helium pressurization, and the final segment was a combined automatic check of J-2 engine system operation.

The procedure was performed twice during the poststorage and coldflow operations. The first issue was initiated on 21 April 1968, and accepted on 23 April 1968. The second issue, initiated on 17 May 1968, during the special coldflow evaluation, was certified as complete on 27 May 1968. The discussion that follows and the test results listed in Test Data Table 4.3.15.1 are from the last issue.

Subsequent to establishing initial conditions, testing of the ambient helium system commenced by pressurizing the ambient helium pneumatic control sphere and repressurization spheres to 700 ± 50 psia and setting the stage control

4.3.15 (Continued)

helium regulator discharge pressure at 515 $\pm$50 psia. A series of checks verified the proper operation of the control helium dump valve and the pneumatic power control module shutoff valve.

The LH_2 and LOX repressurization control module dump valves and control valves were verified to operate properly. A series of checks verified the proper functioning of the O_2H_2 burner spark system and propellant valves.

A three-cycle test of the engine pump purge pressure switch preceded the functional checkout of the engine pump purge valve. The control helium regulator backup pressure switch and the control helium shutoff valve were similarly tested. The control helium sphere was pressurized to 731.02 psia, and the control helium regulator discharge pressure was measured at 534.03 psia, both within acceptable limits. A series of checks verified the operation of the pneumatically controlled valves, including the LH_2 and LOX vent valves, fill and drain valves, prevalves, chilldown shutoff valves, the LH_2 directional vent valve, the LH_2 continuous vent and relief override valve and orificed bypass valve, and the O_2H_2 burner propellant valves and LOX shutdown valve. The LH_2 tank pressurization and continuous vent valve blowdown check completed the ambient helium system test.

Section two, the propellant tanks pressurization systems test, was started with functional checks of the cold helium dump and shutoff valves. The operation of the cold helium regulator backup pressure switch was verified by the three-cycle pressure switch test, as well as by verifying that the switch properly controlled the cold helium shutoff valve.

4.3.15 (Continued)

The LOX and LH_2 repressurization control valves were verified to operate properly, and the operation of the LOX and LH_2 tank repressurization backup pressure switch interlocks was verified by the three-cycle test and by demonstrating that the switches properly controlled the LOX and LH_2 repressurization control valves.

The proper operation of the O_2H_2 burner spark ignition system was verified. The LOX tank pressure switches, the cold helium shutoff valve, and the cold helium heat exchanger bypass valve were verified to operate properly. Proper control of the LOX main fill valve, the LOX auxiliary tank pressurization valve, the LOX replenish valve, and the LOX repressurization valve by the pressure switches was demonstrated.

The LH_2 repressurization and ground fill over-pressurization pressure switches were verified to operate properly. Control of the LH_2 main fill valve, the LH_2 replenish valve, the LH_2 auxiliary tank pressure valve, the step pressure valve, and the repressurization control valve by the pressure switches was also demonstrated. After satisfactory completion of the LH_2 pressure switch checks, the cold helium system was pressurized to 885.00 psia, and the cold helium sphere blowdown and cold helium regulator low flow test were conducted. The cold helium spheres were vented, and a series of checks verified proper operation for the O_2H_2 burner voting circuit and burner malfunction temperature sensors. This completed testing of the propellant tanks pressurization systems.

4.3.15 (Continued)

Section three, the J-2 engine functional tests, was conducted next. The LH_2 and LOX tanks were vented to ambient; the O_2H_2 burner spark systems 1 and 2, the emergency detection systems 1 and 2 engine cutoffs, the repressurization control valves, and the O_2H_2 burner propellant valves were verified to operate properly.

The engine spark test verified proper operation of the thrust chamber augmented spark igniter (ASI) and gas generator spark systems. The engine start tank was pressurized, the proper operation of the start tank vent valve was verified, and the start tank was vented to ambient pressure prior to the engine cutoff test. The engine ready signal was verified to be on, and the simulated mainstage OK signal opened the prevalves. Verification of proper prevalve response to the switch selector engine cutoff signals was made with the prevalves closing to the cutoff signal and opening at signal removal. The engine ignition cutoff test and the LH_2 injector temperature detector bypass test were satisfactorily conducted.

The next series of tests verified that the simulated aft separation signals 1 and 2 individually inhibited engine start and demonstrated proper operation of the LH_2 injector temperature detector bypass and start tank discharge control. During these tests, measurements were made of the helium delay timer, the sparks de-energized timer, and the start tank discharge timer.

Three-cycle tests of mainstage OK pressure switches 1 and 2 were conducted. It was verified that the pickup of either switch turned off the engine thrust

4.3.15 (Continued)

OK 1 and 2 indications, and that after a dry engine start sequence, pickup of either switch would maintain the engine in mainstage. It was also demonstrated that dropout of both pressure switches was required to turn on engine thrust OK indications and cause engine cutoff.

The engine helium control sphere was pressurized to 1463.84 psia to conduct the engine valve sequence tests, which demonstrated that actuation and deactuation of the helium control solenoid valve caused the LH_2 and LOX bleed valves to close and open; that opening and closing the ignition phase control solenoid valve caused the engine augmented spark igniter (ASI) LOX valve and engine main fuel valve to open and close; that the start tank discharge solenoid valve caused the engine augmented spark igniter (ASI) LOX valve and engine main fuel valve to open and close; that the start tank discharge solenoid valve opened and closed; and that opening and closing the mainstage control solenoid valve caused the gas generator valve and main LOX valve to open and close and the LOX turbine bypass valve to close and open.

The final test was the combined automatic functional demonstration of the entire J-2 engine system. The necessary commands were given to initiate engine start and cutoff, and throughout the automatic sequence the engine system responses were verified to be within the predetermined limits.

There were no parts shortages affecting propulsion automatic testing. FARR 500-226-315 reported that the mainstage OK pressure switch number 1 gave an out-of-tolerance reading of 551.94 psia. The maximum pressure indication should have been 551.00 psia. The discrepant switch was removed and replaced.

4.3.15 (Continued)

Fifty-two revisions were made to the procedure as follows:

a. Twenty-eight revisions deleted or added requirements to correct program errors or update the procedure.

b. Eleven revisions deleted sections that were not required for the coldflow evaluation.

c. Two revisions changed the tolerance of the stage external power supply from 28 ± 0.5 vdc to 28 ± 2.0 vdc due to the inability of the external power supply to regulate voltage properly.

d. Two revisions attributed the malfunction of the heat exchanger helium supply number 3 valve not closing in the allotted time of 250 milliseconds to a diode installed across the solenoid to suppress RF interference.

e. One revision stated that a malfunction printout was due to a program error.

f. One revision verified that the transducer power supply voltage was 5.00 ± 0.025 vdc to prevent a possible malfunction indication each time a new section was entered.

g. One revision authorized switching the aft bus 1 from the external power supply to the secondary batteries during the spark test to prevent a possible SIM interrupt due to over-regulation of the power supply.

h. One revision returned the aft bus 1 to the external power supply upon completion of the spark test.

i. One revision attributed an executive error to a newly installed synchronizer in the PCM ground station. This synchronizer was replaced, and no further problems were encountered.

j. One revision stated that the SIM interrupt on channel 67 was due to the engine safety cutoff system power being on prior to the matrix reset during the initial scan portion of the procedure.

k. One revision authorized turning power on to the common bulkhead, the LOX ullage, and the LH_2 transducers after stage power setup. These commands were turned off during the matrix reset and must be on for this test.

4.3.15 (Continued)

l. One revision reran the LH_2 tank pressure routine for the continuous vent test. The helium supply to the test stand ran low preventing complete pressurization of the LH_2 tank.

m. One revision attributed the out-of-tolerance reading of the mainstage pressure switch number 1 to a defective switch. This switch was removed and replaced on FARR 500-226-315. A test of the new switch was acceptable.

4.3.15.1 Test Data Table, Propulsion Test

Section 1 - Ambient Helium Test

Function

Engine Pump Purge Pressure Switch Checkout

		Measured Values			
		Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	120.91	120.91	120.13	136.0 max
Dropout Pressur	(psia)	110.03	111.59	113.91	99.0 min
Deadband	(psid)	10.88	9.32	6.22	3.0 min

Control Helium Regulator Backup Pressure Switch Checkout

		Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	60.428	25.132	25.029	180.0 max
Pickup Pressure	(psia)	602.66	597.98	597.20	600 ± 21
Depressurization Time	(sec)	9.518	9.152	9.174	180.0 max
Dropout Pressure	(psia)	489.99	490.77	491.54	490 ± 31

Pneumatically Controlled Valve Timing Checkout

	Operating Times (sec)					
Valve	Open	Total Open	Close	Total Close	Boost Close	Total Boost Close
LH_2 Vent Valve	0.016	0.076	0.199	0.462	0.075	0.240
LOX Vent Valve	0.023	0.086	0.112	0.343	0.065	0.200
LOX F&D Valve	0.146	0.269	0.731	2.217	0.426	0.931
LH_2 F&D Valve	0.112	0.245	0.734	2.081	0.361	0.840
LOX Prevalve	1.334	1.995	0.180	0.312	*	*
LH_2 Prevalve	1.313	1.949	0.186	0.323	*	*
LOX C/D SOV	0.301	1.181	0.030	0.135	*	*
LH_2 C/D SOV	0.187	1.067	0.008	0.124	*	*

* Not applicable to these valves

4.3.15.1 (Continued)

Valve	Operating Times (sec) Open	Total Open	Close	Total Close	Boost Close	Total Boost Close
LH_2 Cont Vent Orif'd Bypass Valve	0.007	0.040	0.008	0.068	*	*
O_2H_2 Burner LH_2 Prop	0.045	0.134	0.072	0.236	*	*
O_2H_2 Burner LOX Prop	0.065	0.183	0.065	0.184	*	*
O_2H_2 LOX S/D Valve	0.007	0.088	0.009	0.145	*	*

Valve	Flight Position	Total Flt. Position	Ground Position	Total Ground Position
LH_2 Directional Vent Valve	0.064	0.153	0.838	1.397

Section 2 - Propellant Tanks Pressurization System Test

Function

Cold Helium Regulator Backup Pressure Switch Checkout

		Measured Values Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	40.921	19.945	19.903	180 max
Pickup Pressure	(psia)	462.80	464.34	465.13	467.5 ± 23.5
Depress. Time	(sec)	13.579	13.640	13.602	180 max
Dropout Pressure	(psia)	365.66	364.11	364.88	362.5 ± 33.5

LOX Tank Repressurization Backup Pressure Switch Checkout

Pressurization Time	(sec)	19.434	38.066	38.599	180 max
Pickup Pressure	(psia)	462.02	361.24	460.45	467.5 ± 23.5
Depress. Time	(sec)	11.777	11.671	11.579	180 max
Dropout Pressure	(psia)	377.32	376.54	377.32	362.5 ± 33.5

LH_2 Tank Repressurization Backup Pressure Switch Checkout

Pressurization Time	(sec)	42.732	43.152	42.357	180 max
Pickup Pressure	(psia)	475.23	474.45	473.66	467.5 ± 23.5
Depress. Time	(sec)	13.239	13.217	13.266	180 max
Dropout Pressure	(psia)	375.77	375.77	374.21	362.5 ± 33.5

* Not applicable to these valves

4.3.15.1 (Continued)

		Measured Values			
		Test 1	Test 2	Test 3	Limits
LOX Tank Ground Fill Over-Pressure Pressure Switch Checkout					
Pressurization Time	(sec)	25.532	20.745	15.202	180 max
Pickup Pressure	(psia)	40.80	40.74	40.80	41 max
Depress. Time	(sec)	4.150	3.984	3.786	180 max
Dropout Pressure	(psia)	39.28	39.28	39.28	37.5 min
Deadband	(psid)	1.51	1.46	1.51	0.5 min
LH_2 Repressurization Control Pressure Switch Checkout					
Pressurization Time	(sec)	111.926	29.392	28.941	180 max
Pickup Pressure	(psia)	33.63	33.53	33.63	34 max
Depress. Time	(sec)	36.980	31.646	32.539	180 max
Dropout Pressure	(psia)	31.80	31.85	31.85	30.8 min
Deadband	(psid)	1.83	1.68	1.78	0.5 min
LH_2 Tank Ground Fill Over-Pressure Pressure Switch Checkout					
Pressurization Time	(sec)	99.320	51.114	31.791	180 max
Grd. Fill Over-Press. Pickup Press.	(psia)	33.53	33.53	33.42	34 max
Depress. Time	(sec)	49.891	40.917	40.560	180 max
Grd. Fill Over-Press. Dropout Pressure	(psia)	31.33	31.33	31.33	30.8 min
Deadband	(psid)	2.20	2.20	2.09	0.5 min

Section 3 - J-2 Engine Functional Test (Engine S/N J-2091)

Engine Delay Timer Checkout

Function	Delay Time (sec)	Limits (sec)
Ignition Phase Timer	0.433	0.450 ± 0.030
Helium Delay Timer	1.006	1.000 ± 0.110
Sparks De-energized Timer	3.304	3.300 ± 0.200
Start Tank Discharge Timer	1.004	1.000 ± 0.040

4.3.15.1 (Continued)

Function

Mainstage OK Pressure Switch 1 Checkout

		Measured Values			
		Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	531.0	534.0	535.0	515 ± 36
Dropout Pressure	(psia)	462.0	456.0	463.0	*
Deadband	(psid)	69.0	78.0	72.0	62.5 ± 48.5

Mainstage OK Pressure Switch 2 Checkout

		Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	510.96	510.19	509.41	515 ± 36
Dropout Pressure	(psia)	443.37	444.91	444.91	*
Deadband	(psid)	67.59	65.27	64.50	62.5 ± 48.5

Engine Sequence Check

Function	Start or Delay Time (sec)	Oper. or Travel Time (sec)	Total Time (sec)
Engine Start			
Cont He Solenoid Command Talkback	**	0.013	**
Ign Phase Cont Solenoid Command Talkback	**	0.006	**
ASI Valve Open	**	0.041	**
Engine LOX Bleed Valve Close	**	0.082	**
Engine LH_2 Bleed Valve Close	**	0.059	**
Main Fuel Valve Open	0.073	0.061	0.134
Start Tank Disch Timer	**	1.006	**
Start Tank Disch Valve Open	0.089	0.124	0.213
Mainstage Cont Solenoid Energized	**	1.455	**
Ignition Phase Timer	**	0.449	**
Start Tank Disch Cont Solenoid De-energized	**	0.006	**
Main LOX Valve Open	0.443	1.733	2.177
Start Tank Disch Valve Close	0.191	0.137	0.328
Gas Generator Valve Open	**	0.094	0.189
LOX Turbine Bypass Valve Close	0.030	0.405	0.436
Spark System Off Timer	**	3.315	**

*Limits not specified
**Not applicable or not available

4.3.15.1 (Continued)

Function	Start or Delay Time (sec)	Oper. or Travel Time (sec)	Total Time (sec)
Engine Cutoff			
Ign Phase Cont Solenoid De-Energized from Cutoff	*	0.007	*
Mainstage Cont Solenoid De-Energized from Cutoff	*	0.014	*
ASI Valve Close	0.037	*	*
Main LOX Valve Close	0.122	0.044	0.166
Main Fuel Valve Close	0.131	0.147	0.278
Gas Generator Valve Close	0.139	0.107	0.246
He Cont De-Energized Timer	*	1.016	*
Engine LOX Bleed Valve Open	*	*	8.060
Engine LH_2 Bleed Valve Open	*	*	7.780
LOX Turbine Bypass Valve Open	0.295	0.513	0.808

*Not applicable or not available

4.3.16 Digital Data Acquisition System (1B55817 J)

The digital data acquisition system (DDAS) test provided operational status verification of data channels on the stage, except certain data channels that were tested during specific system tests. The outputs of the tested channels were checked by the GSE D924A computer and found to be within the specified tolerances. The proper operation of all DDAS signal conditioning units and associated amplifiers, the remote automatic calibration system (RACS) and the command calibration channel decoder assemblies, and the telemetry transmitter and antenna system were also checked by the computer.

Components tested by this procedure consisted of the PCM/DDAS assembly, P/N 1B65792-1, S/N 6700092, which replaced P/N 1A74049-511, S/N 016, during testing; the CP1-BO time division multiplexer, P/N 1B62513-547, S/N 013; the DP1-BO time division multiplexer, P/N 1B62513-543, S/N 014; the remote digital submultiplexer (RDSM), P/N 1B52894-501, S/N 025; the low level remove analog submultiplexer (RASM), P/N 1B66050-501, S/N 08, which replaced P/N 1B54062-505, S/N 040 during testing; and the PCM RF assembly, P/N 1B52721-521, S/N 011, which replaced P/N 1B52721-521, S/N 034, during testing.

The procedure was issued four times to support poststorage testing. The initial test was conducted per the first issue on 23 April 1968. This issue was modified to accommodate the coldflow only. Replacement of the PCM/DDAS per FARR A270665 during stage power setup on 30 April 1968, necessitated a repeat of the initial test prior to the coldflow. This was accomplished successfully per issue two on 30 April 1968. The third and fourth issues were standard versions to support all systems testing (AST). The third issue consisted of two test

4.3.16 (Continued)

attempts. The first attempt was conducted on 27 May 1968, after replacement of the RASM per FARR 500-226-366, due to malfunction during a preliminary DDAS engineering evaluation run, also conducted on the same date. The second attempt was tested on 29 May 1968 due to the replacement of the 20 volt excitation module, P/N 1A74036-1, S/N 0310, per FARR 500-226-382, after the first test attempt on 27 May 1968. The fourth and final issue was necessary to verify the system integrity after replacement of the PCM RF assembly during AST testing per FARR 500-225-271. This test was conducted successfully on 12 June 1968, completing the DDAS automatic testing. Variable data quoted in the body of this narrative is taken from the final test of the component concerned unless otherwise noted. Malfunction indication, out-of-tolerance measurements, and other problem areas for each test conducted are itemized in the revision discussion for this narrative.

All channels having a calibration capability were compared one at a time, by the computer, to the tolerance limits. Transducer analog outputs were signal conditioned and fed to the multiplexers. The multiplexer unit input channels were electronically sampled at a given rate, then these samples were fed into the digital data acquisition assembly (DDAA). The DDAA received these output samples through a time share gate and converted them to 10 bit binary coded words. The DDAA output was fed into the ground station and the PCM RF transmitter by coaxial cable. The ground station output was fed into the computer for tolerance verification.

4.3.16 (Continued)

High mode or low mode calibration command signals were provided, by the remote automatic calibration systems (RACS), by binary coded ground commands to a central calibration command decoder assembly in the stage. These signals were fed into the signal conditioning modules to provide channel operation verification in the DDAS.

Channels without RACS capability and spare channels were tested by comparing the end item outputs at ambient conditions to tolerance limits. Ambient conditions were defined as 70°F at 14.7 psia, and for bilevel parameters, the normal state of values or switches during the performance of this test. All channel outputs were measured and the output printed out.

The telemetry antenna system operation was checked by verifying that the PCM RF assembly output forward power, the antenna system reflected power, and the antenna system VSWR were all acceptable.

After establishing initial conditions, a DDAS ground station calibration was performed to verify that the DDAS ground station and peripheral equipment were properly setup and ready for test.

During the final PCM RF test on 12 June 1968, the forward and reflected RF output powers of the PCM/DDAS assembly were measured through the CP1-BO and DP1-BO multiplexer telemetry outputs; and the voltage standing wave ratios (VSWR) were determined. The same measurements were also made through the ground monitor outputs for both multiplexers. Measurements of the final test were next. The CP1-BO multiplexer telemetry readings were forward power, 21.474 watts; reflected power, 4.645 watts; VSWR, 2.737. The

4.3.16 (Continued)

DP1-BO multiplexer telemetry readings were: forward power, 21.414 watts; reflected power, 4.530 watts; VSWR, 2.702. The CP1-BO multiplexer ground monitor readings were: forward power, 17.429 watts; reflected power, 0.586 watts; VSWR, 1.449. The DP1-BO multiplexer ground monitor readings were: forward power, 17.488 watts; reflected power, 0.617 watts; VSWR, 1.462. High and low RACS tests were then conducted on measurement channel CP1-BO-05-10 for the aft 5 volt excitation module voltage, while both the ground monitor and telemetry outputs were measured. High RACS for telemetry and ground monitor outputs were 3.999 vdc and 3.989 vdc, respectively. Low RACS were -0.005 vdc and -0.010 vdc, respectively, for telemetry and ground monitor outputs. All measurements were within the acceptable tolerances.

The final CP1-BO multiplexer test was accomplished on 29 May 1968. This test made measurements of the high and low RACS voltages of each channel having calibration capability, and measurements of the ambient outputs in units of temperature, pressure, voltage, current, frequency, event indication, liquid level indication, and position indication, as applicable for the various channels. Output values for each of the CP1-BO multiplexer channels tested were within the required limits.

The final DP1-BO multiplexer test was also run on 29 May 1968, except for special channels, in the same manner as described for the CP1-BO multiplexer with no malfunctions. All channel outputs were within tolerance.

Special channel tests were also conducted. These special channels measured 400 Hz, 100 Hz, and 1500 Hz signals. The 400 Hz test checked the static

4.3.16 (Continued)

inverter-converter frequency, the LOX and LH_2 chilldown inverter frequencies, and the LOX and LH_2 circulation pump flow rates. The LOX and LH_2 flowmeter tests at 100 Hz followed the 400 Hz test, and the LOX and LH_2 pump speeds were checked using the 1500 Hz signal. All of these special channels were within the required tolerance of the expected values.

An APS multiplexer test and a J-2 engine pressure multiplexer test were run to check those channels on both multiplexers that measured the APS and special J-2 engine functions. The APS units, S/N 1010-1 and S/N 1010-2, had previously been installed on the stage for poststorage test operations. Measurements were made of the high and low RACS voltages for each of the APS and special J-2 engine channels having calibration capability; and the ambient outputs were measured in degrees Fahrenheit or psia, as appropriate for the channel tested. All APS and J-2 engine special channels were within the required tolerances.

The last check conducted was the umbilical measurements test. Umbilical measurements were made for ambient pressure and voltage checks of the LOX and LH_2 chilldown pump differential pressure transducers. After the umbilical checks, these measurements were returned to their respective telemetry channels and verified. Next, a multiplexer test was run for the common bulkhead internal pressure channel including high and low RACS voltages and ambient output pressure. Then, additional umbilical measurements included the 20 percent and 80 percent calibration checks of the common bulkhead pressure and the umbilical LOX and LH_2 ullage pressure measurements. Ambient pressure checks of the LOX and LH_2 emergency detection system transducers completed the umbilical measurements test. All measurements for the final test were within tolerance, and the DDAS was accepted for use.

4.3.16 (Continued)

There were no parts shortages during the final tests of the DDAS and no interim use hardware installed. Twenty-six revisions were recorded in the procedure for issue one, twenty-three revisions for issue two, fifteen revisions for issue three, and ten revisions for issue four.

Issue one revisions were as follows:

a. Six revisions corrected program errors.

b. One revision deleted backup pressure measurements from the program, authorized by WRO 4009, because these were not incorporated prior to the all systems test.

c. One revision deleted the period counter echo checks from the program because the response conditioner was not wired to comply with this checkout.

d. One revision changed the 2-second flip-flop sense code in the computer interface unit to incorporate the manual control detection and ground instrumentation system interface control modification.

e. One revision added the redundant backup measurement D248, cold helium sphere pressure, into the program.

f. One revision modified the digital data tape (DDT) curves as required for the umbilical measurements of the chilldown pump differential pressures.

g. One revision provided program changes necessary to verify LOX and LH_2 chilldown pump differential pressure measurements that were returned to their respective telemetry channels after the umbilical checks were completed.

h. One revision deleted a requirement to install an electrical test setup because the installation had previously been accomplished by the electrical preparations procedure, 1B73193.

i. One revision was required to load the expected value and tolerance into the program for the hydraulic reservoir oil level, measurement L007.

j. One revision modified the program so that special APS functions were tested in the APS multiplexer test only.

4.3.16 (Continued)

k. One revision was required to provide correct tolerance assignments for the APS multiplexer test because the APS modules, rather than simulators, were installed.

l. Two revisions noted channel malfunctions that occurred as a result of transducers electrically disconnected or not installed because they were not required for the coldflow. These channels were checked out during the post-coldflow DDAS tests, which were conducted to support the all systems test (ast).

m. Three revisions concerned channel malfunctions that occurred due to previously rejected transducers and microswitches which were dispositioned to remain installed until coldflow completion.

n. One revision noted that malfunctions on several channels were due to pressurization of systems for concurrent testing when the DDAS test began. After venting these systems to ambient, the test of these channels was repeated satisfactorily.

o. One revision concerned out-of-tolerance forward PF power telemetry measurements for the CP1-BO and DP1-BO multiplexer tests, attributing this to RFl sensitivity to the test stand environment.

p. One revision corrected a program error that resulted in a malfunction of channel CP1-BO-13-06, measurement D043, GN_2 accumulator pressure.

q. One revision corrected a programming error that resulted in a channel malfunction for measurement L007, hydraulic reservoir oil level.

r. One revision concerned APS channel malfunctions that occurred due to failure to program the actual ambient temperatures for the APS modules. The measurements obtained were correct for the temperatures that existed at the time of the test.

Issue two revisions were as follows:

a. Six revisions were corrections of program errors identical with those for issue one of the procedure.

b. Thirteen revisions were identical to those for issue one of the procedure--revisions b through m respectively.

4.3.16 (Continued)

c. One revision provided a program change to obtain DDT curve consistency for both multiplexer (DP1-BO and CP1-BO) tests of measurement D043, GN_2 accumulator pressure.

d. One revision indicated that an out-of-tolerance GSE 5 volt transducer power supply was adjusted and then verified by the program to be within tolerance.

e. One revision concerned out-of-tolerance ambient output for measurement C388, hydraulic line number 2 temperature, attributing the cause to a substantial difference between the actual ambient temperature and the expected ambient entered into the program prior to the test.

f. One revision indicated that the out-of-tolerance Hi RACS test of measurement N063, P.U. oven stability monitor, was caused by a defective amplifier, P/N 1A82395-1, S/N 2317. The amplifier was rejected on FARR A270666 for replacement and DDAS verification after the coldflow test.

Issue three revisions were as follows:

a. One revision for the preliminary stage power setup revised the tolerances on the 28 vdc power supplies from ± 0.5 to ± 2.0 vdc due to lack of filters on the power supply remote sense lines required for close tolerance voltage regulation.

b. Three revisions were corrections of program errors identical to issues one and two.

c. Five revisions were identical to those for issue one of the procedure--revisions b, g, h, j, and k.

d. Two revisions were identical to revision e of issue two, but also included measurements C393 and 394, thrust structure temperatures, plus measurement C022, attitude control oxidizer APS module 2 temperature, in addition to measurement C388.

e. Three revisions explained SIM interrupts and event malfunctions for the engine safety cutoff that were received because of operator errors.

f. One revision authorized the second test for issue three that was required after replacement of the 20 volt excitation module per FARR 500-226-382, as previously noted in this narrative.

4.3.16 (Continued)

Issue four revisions were as follows:

a. Three revisions were corrections of program errors identical to the first three issues.

b. Five revisions were identical to issue one--revisions b, g, h, j, and k.

c. One revision authorized the retest of the PCM RF portion of the test, per issue four, after the replacement of the PCM RF assembly, per FARR 500-225-271, as noted previously in this narrative.

d. One revision changed the program to terminate the test, per issue four, at the conclusion of the PCM RF portion of the DDAS automatic test procedure.

4.3.17 Signal Conditioning Setup (1B44474 D)

This procedure calibrated the stage 5 volt and 20 volt excitation modules and calibrated any items of the stage signal conditioning equipment that were found to be out of tolerance during testing. The signal conditioning equipment consisted of those items required to convert transducer low level or ac signals to the 0 to 5 vdc form used by the telemetry system and included dc amplifiers, temperature bridges, frequency to dc converters, and expanded scale voltage monitors. Only the particular items calibrated during this procedure are noted below and in Test Data Table 4.3.17.1

The procedure was initiated on 19 April 1968, and was certified as completed on 3 June 1968. The stage power setup, H&CO 1B55813, was performed prior to any calibration activity to provide electrical power to the equipment.

Three 5 volt excitation modules were calibrated. The input voltage to each module was verified to be 28 ±0.1 vdc; and each module was adjusted to obtain a 5 vdc output of 5.0 ±0.005 vdc, a -20 vdc output of -20.00 ±0.005 vdc, and an ac output of 10 ±1 volt peak-to-peak at 2000 ±200 Hz. The final values measured, as shown in the Test Data Table, were all within the above limits. The ac output measurements were made with the test switch set to four different positions, sequentially, and were found to be the same for each position.

Six 20 volt excitation modules were calibrated by adjusting the coarse control and fine control on each module to obtain an output of 20.000 ±0.005 vdc. As shown in the Test Data Table, the final measured value for each module was within the above limits.

4.3.17 (Continued)

Three temperature bridges required calibration--the hydraulic line 3 temperature, the oxidizer tank pressure module temperature, and the PU oven stability monitor bridge.

No part shortages were recorded that affected this test. FARR 500-226-366 reported that NASA measurement C387 failed to automatically calibrate properly after initial setup. The output drifted to an out-of-tolerance reading for high level calibration of 4.138 vdc and 0.078 vdc for low level calibration. The reading should have been 4.0 ±.075 vdc and 0 ±.075 vdc, respectively. The trouble was traced to a faulty analog submultiplexer, P/N 1B54062-505, which was removed and replaced. The retest was acceptable and this procedure was complete. Ten revisions were made to this procedure for the following:

a. One revision added the requirement for calibration of temperature bridge N063. This parameter was added to the stage after release of this procedure.

b. One revision authorized substituting cable assembly P/N 1B04913-663 in place of P/N 1B64101-1. The P/N 1B04913-663 is electrically identical to the 1B64101-1, and the later was not available.

c. One revision added the provision for recording the data for measurement C387. The measurement had been erroneously omitted from the Test Data Table.

d. Two revisions authorized special integrity checks of temperature bridge C387 by substituting an identical bridge assembly into the C387 circuit.

e. One revision authorized a special circuit to functionally check the operation of the analog submultiplexer for measurement C387.

f. One revision authorized recalibration of measurement C387 after replacement of the analog submultiplexer per FARR 500-226-366.

4.3.17 (Continued)

g. One revision provided special electrical connections to the 5 volt excitation module, 411A99A33, and the 20 volt module, 411A61A242, to verify proper input voltages. After the test, the circuits were returned to pretest configuration.

h. One revision authorized performing calibration of the 20 volt excitation module, 411A61A242, and two 5 volt excitation modules, 411A99A33 and 411A98A2. These units were replaced after the static firing and required calibration.

i. One revision deleted all sections of the test that were not required, as the procedure was used for only those components that had been removed and replaced or were found to be out-of-tolerance during automatic checkouts.

4.3.17.1 Test Data Table, Signal Conditioning Setup

5 Volt Excitation Module - P/N 1A77310-503.1

Reference Location	S/N	5 vdc Output (vdc)	-20 vdc Output (vdc)	ac Output vpp	ac Output Hz
411A99A33	0170	5.003	-20.002	10.0	2003
404A52A7	0171	5.000	-20.001	9.6	2014
411A98A2	0103	5.000	-19.999	9.1	2012

20 Volt Excitation Module - P/N 1A74036-1.1

Reference Location	S/N	20 vdc Output (vdc)
411A61A242	0368	20.004
404A62A241	0307	19.999
404A63A241	0279	20.000
404A64A241	0311	20.000
404A65A241	0308	20.002
404A63A233	0281	20.000

4.3.17.1 (Continued)

Temperature Bridges

Function	Reference Location	S/N	Measurement		Limits
PU Oven Stability Monitor	411A61A214	0168	Low	-.0004 vdc	0 ± .005 vdc
			High	+.0006 vdc	4 ± .005 vdc
Temp Oxidizer Tank Press Module	404A62A25	1429	Low	0.02 mvdc	0 ± 0.05 mvdc
			High	24.2 mvdc	24.0 ± 0.3 mvdc
Temp Hydraulic Line 3	404A66A208	993	Low	0.0 mvdc	0 ± 0.05 mvdc
			High	24.0 mvdc	24.0 ± 0.3 mvdc

4.3.18 Exploding Bridgewire System (1B55822 F)

This automatic procedure verified the design integrity of the exploding bridgewire (EBW) system and demonstrated the operational capability of the EBW system to initiate ullage rocket ignition and jettison when commanded by the instrument unit during flight. The particular items involved in this test were:

Part Name	Ref. Location	P/N	S/N
Ullage Rocket Ignition System			
EBW Firing Unit	404A47A1	40M39515-113	285
EBW Firing Unit	404A47A2	40M39515-113	282
Pulse Sensor *	404A47A4A2	40M02852	-
Pulse Sensor *	404A47A4A2	40M02852	-
* On Pulse Sensor Bracket Assy	404A47A4	1B52640-1	1
Ullage Rocket Jettison System			
EBW Firing Unit	404A75A1	40M39515-113	277
EBW Firing Unit	404A75A2	40M39515-113	283
Pulse Sensor **	404A75A10A1	40M02852	-
Pulse Sensor **	404A75A10A2	40M02852	-
** On Pulse Sensor Bracket Assy	404A75A10	1A97791-501	3

This procedure was accomplished on 8 May 1968, and was accepted on the same date. Throughout this procedure, the charged condition of each EBW firing unit was determined by verifying that the firing unit voltage indication measured 4.2 $\pm$0.3 vdc, while the uncharged or discharged condition was determined by verifying that the voltage indication measured 0.0 $\pm$0.3 vdc, or during the flight unit disable test, 0.2 $\pm$0.3 vdc.

The stage power setup, H&CO 1B55813, was accomplished and initial conditions were established. An EBW pulse sensor self test was conducted first by verifying that the self test command properly turned on the four EBW pulse sensors and that the reset command properly turned off the pulse sensors.

4.3.18 (Continued)

The ullage ignition EBW firing units were tested next. The charge ullage ignition command was verified to properly charge both ullage ignition EBW firing units, while both ullage jettison EBW firing units remained uncharged. To verify that the fire ullage ignition command properly fired the ullage ignition EBW firing units, it was determined that both ignition pulse sensors were turned on, while both jettison pulse sensors remained off, and that both ullage ignition EBW firing units were discharged.

The ullage jettison EBW firing units were tested in the same way by verifying that the charge ullage jettison command charged the ullage jettison EBW firing units and that the fire ullage jettison command fired the jettison firing units and turned on the jettison pulse sensors.

A series of checks then verified that the EBW ullage rocket firing unit disable command prevented the firing units from charging when the charge ullage ignition and charge ullage jettison commands were turned on and discharged the firing units, while preventing them from firing when the fire ullage ignition and fire ullage jettison commands were turned on.

A final series of checks verified the operation of the EBW pilot relay by determining that the pilot relay reset indication was off after each of the charge ullage ignition and jettison, that the fire ullage ignition and jettison commands were turned on, and that the pilot relay reset indication was on after each command was reset.

Engineering comments noted that all parts were installed at the start of this checkout. No problems were encountered during this test, and no FARR's were written.

4.3.19 Auxiliary Propulsion System Checkout (1B70430 NC)

Contained in this manual and automatic checkout were the procedures required to verify the functional capabilities of the auxiliary propulsion system (APS) when mated to the stage. This procedure defined the preliminary preparation, safety requirements, and detailed manual operations necessary for checkout.

The checkout was initiated on 9 May 1968, after verification of satisfactory completion of the APS and stage interface compatibility checkout, H&CO 1B49558.

After the initial setup, which included measuring and recording fuel and oxidizer tank and manifold pressures on APS module 1, a fuel valve functional and system leak check was performed. The blanket pressure line was connected to port "J" on APS 1, and the fuel tank transfer valve open command was executed. The APS panel blanket pressure supply valve was opened, and the hand loader regulator was set at 20 ±5 psig. The APS blanket pressure valve was opened; then, the fuel manifold pressure was measured and recorded. Cycling of the fuel tank recirculation valve was accomplished, and it was verified that helium flowed from port "L" as the recirculation valve was opened and ceased when the valve was closed. The recirculation valve was again commanded open, and helium flow was again noted at port "L." The flow ceased when the fuel tank transfer valve was closed. The fuel tank recirculation valve and the fuel tank transfer valve were opened. After verification that the fuel manifold pressure had stabilized, both valves were closed. The APS blanket pressure panel was secured. The APS fuel manifold pressure was recorded; and after 5 minutes, a final pressure reading was taken. The same test procedure was repeated for the oxidizer section of APS 1.

4.3.19 (Continued)

A helium valve functional test was accomplished next. The APS blanket pressure line was connected to the helium bottle fill line between the first two check valves of APS 1. The blanket pressure handloader regulator was set to 40 ±5 psig, and bleed valve V-3315 was closed. The APS 1 fuel and oxidizer ullage pressures were reported and entered in Test Data Table 4.3.19.1.

The APS fuel and oxidizer tank ullage and emergency ullage vent valves were opened for 1 second, then closed. The APS blanket pressure panel was again secured, and the fuel and oxidizer ullage pressures were monitored for 5 minutes. The initial and final pressures were noted and recorded.

The pressure scan and engine valve function test for APS 1 was the next section completed. The blanket pressure regulator was set to 25 ±5 psig, and the bleed valve was closed. The APS 1 blanket pressure valve was opened, and the fuel tank and oxidizer tank transfer valves were opened. The APS automatic checkout was called up on the automatic checkout system, and the manual automatic control switch was placed in the automatic mode. During this section of the test, the computer verified several APS functions. Upon completion of the automatic test, manual control was resumed. The magnetic amplifier output voltage required to cycle the engine valves was noted and recorded.

The APS 1 blanket pressures were re-established and recorded; then, the fuel and oxidizer tank transfer valves were closed. The blanket pressure panel bleed valve was opened, and the hand loader regulator was secured; then, the bleed valve was closed. Final securing from the APS 1 test was accomplished by closing the APS 1 blanket pressure valve and the blanket pressure supply valve.

4.3.19 (Continued)

The test, as performed on APS 1, was repeated for APS 2 with the exception of the oxidizer tank sections, as the oxidizer tank had been removed for rework. All data for APS 1 and APS 2 are found in the Test Data Table.

The oxidizer tank, P/N 1B63924-506, was not installed in APS 2 during this test. The tank was installed on 12 July 1968, and checkout was accomplished per APS checkout 1B60960.

Inspection Item Sheet 384020 reported that the APS 2 fuel manifold blanket pressure was at ambient due to a leak at the throat plug exit port in the number 2 engine. A retest per the APS checkout 1B60960 was acceptable.

No FARR's were written as a result of this test, and the procedure was accepted on 6 July 1968.

Seven revisions were written to the procedure:

a. Two revisions deleted the sections concerning the oxidizer tank checkout for APS 2, as the tank was not installed at the time of this test.

b. Two revisions added requirements to establish ambient pressures to support the performance of the DDAS procedure.

c. One revision changed a connection point callout from port "P" to "the helium bottle fill line between the first two check valves." Port "P" was located in an unaccessible position.

d. One revision authorized closing the APS 2 valve V-3317 to maintain blanket pressure until after completion of manual control.

e. One revision added the steps necessary to secure the APS modules after the performance of AST.

4.3.19.1 Test Data Table, Auxiliary Propulsion System Checkout

Module Setup	APS 1	APS 2	Limits
Fuel Tank Pressure (psig)	4.0	4.0	0.5 min
Fuel Ullage Pressure (psia)	.0179	18.8	*
Fuel Manifold Pressure (psia)	.0109	12.2	*
Oxidizer Tank Pressure (psig)	4.0	N/R	0.5 min
Oxidizer Ullage Pressure (psia)	.0118	N/R	*
Oxidizer Manifold Pressure (psia)	.0118	N/R	*
Fuel Valve Functional Check			
Fuel Manifold Pressure			
Initial (psia)	27.9	29.2	35 ± 15
Final (psia)	27.9	29.2	35 ± 15
Oxidizer Valve Functional Check			
Oxidizer Manifold Pressure			
Initial (psia)	31.4	28.4	35 ± 15
Final (psia)	31.4	28.8	35 ± 15
Helium Valve Functional Check			
Fuel Ullage Pressure (psia)	49.3	42.8	50 ± 15
Oxidizer Ullage Pressure (psia)	41.5	N/R	50 ± 15
Engine Valve Functional Test			
Voltage Required for Valve Cycle			
Engine 1 (vdc)	4.020	3.948	*
Engine 2 (vdc)	4.076	3.953	*
Engine 3 (vdc)	3.989	3.943	*
Blanket Pressures (psia)			
Oxidizer Ullage	42.8	40.6	*
Fuel Ullage	50.2	45.0	*
Fuel Manifold	27.9	0	*
Oxidizer Manifold	29.7	30.6	*

*Limits not specified

4.3.20 Auxiliary Propulsion System Test (1B66774 A)

Contained in this automatic checkout were the procedures which verified the design integrity and operational capability of the auxiliary propulsion system (APS) electrical system for the flight stage.

Initial conditions for the test were established with the performance of the stage power setup procedure, H&CO 1B55813, on 9 May 1968. The instrument unit (IU) substitute power supply was turned on and measured. The APS 1 test was started by measuring the helium sphere and helium regulator outlet pressure through the AO and BO multiplexers. The helium sphere, oxidizer tank, and fuel tank temperatures were measured. The fuel and oxidizer ullage pressure were then measured.

The APS 1 engine propellant transfer valve test was accomplished next. The APS firing command was turned on, and the 1-2 engine valve open indication was verified to be 0.00 vdc (closed position). The aft bus 1 voltage was then measured. With the APS firing command turned off, the 1-2 engine valve was commanded open, then closed. During valve movement, the following functions were monitored and recorded: time, valve voltage, thrust chamber pressure, and oxidizer and fuel manifold pressures. The 1-2 engine propellant transfer valve full open indication was measured by the BO multiplexer. The APS firing enable command was turned off, the aft bus 1 voltage was measured, and the 1-3 engine propellant transfer valve open indication was verified to be -0.0005 vdc (closed position).

With the APS 1 firing command turned off, the propellant transfer valve for the 1-3 engine was operated; and the operating elapsed time, valve voltage,

4.3.20 (Continued)

thrust chamber pressure, and oxidizer and fuel manifold pressures were recorded. The propellant transfer valve full open indication was measured, and the firing command was turned on. The transfer valve was closed, the open indication was recorded at 0.000 vdc, and the aft bus 1 voltage was measured.

The APS 1 firing command was again turned off, and the test repeated for the 1-1 engine propellant transfer valve.

Upon completion of the APS 1 engine propellant transfer valve test, the entire test was repeated for APS 2.

The APS 1 and 2 ullage engine propellant transfer valves, engine 1-4 and 2-4, were then tested using the same method as that used for the attitude control engines.

All measured values are listed in Test Data Table 4.3.20.1. The checkout was completed on 24 May 1968, and was accepted on 3 June 1968.

There were eight revisions written during the course of this procedure:

a. One revision added the requirement for the Test Requirement APS Subsystem Auto, SIV/SV, 1B62711, to this procedure per NASA request.

b. One revision added a reference to the Sacramento Test Center Safety Brochure.

c. One revision changed the APS 1 pre-test setup to 1B70430 in lieu of Paragraph 4.1.2.

d. One revision changed the APS 2 pre-test setup to 1B70430 in lieu of Paragraph 4.3.1.

4.3.20 (Continued)

e. One revision accepted, for this test, an out-of-tolerance reading of 39.71 psia for the APS 2 oxidizer ullage pressure. The pressure should have been 50 ±10 psia.

f. One revision stated that the telemetry systems display console was not used to record data, due to failure of the console. All necessary data was recorded on the telemetry tape unit.

g. One revision performed the APS 1 and 2 ullage engine test to verify proper operation of the ullage engine commands after correction of a wiring error which caused the lack of isolation of the engine commands reported on FARR 500-226-340.

h. One revision changed the tolerance for the bus 1 voltage from 28 ±0.5 vdc to 28 ±2 vdc.

There were no FARR discrepancies, and the APS system was accepted for use.

4.3.20.1 Test Data Table, Auxiliary Propulsion System

APS 1 Test

Function	Meas.	AO Multi	BO Multi	Limit
IU Substitute Power (vdc)	-27.96			-28.5 ± 2.5
Helium Sphere Pressure (psia)		68.7	61.1	100.0 max
Helium Regulator Outlet (psia)		44.1	44.1	50.0 ± 10.0
Helium Sphere Temperature (°F)		74.8	-	*
Oxidizer Tank Temperature (°F)		71.9	71.8	*
Fuel Tank Temperature (°F)		73.2	73.0	*
Fuel Tank Ullage Pressure (psia)		50.6	-	50.0 ± 10.0
Oxidizer Tank Ullage Pressure (psia)		42.3	-	50.0 ± 10.0
Fuel Manifold Pressure (psia)		32.3	-	40.0 ± 20.0
Oxidizer Manifold Pressure (psia)		34.5	-	40.0 ± 20.0
Engine 1-2 Valve Test				
Valve Open Ind (Closed) (vdc)	-0.005			*
Aft Bus 1 Voltage (vdc)	28.278			*
Valve Open Ind (Open) (vdc)	4.061			*
Engine 1-3 Valve Test				
Valve Open Ind (Closed) (vdc)	0.000			*
Aft Bus 1 Voltage (vdc)	28.478			*
Valve Open Ind (Open) (vdc)	3.969			*

* Limits Not Specified

4.3.20.1 (Continued)

Function	Meas.	AO Multi	BO Multi	Limit
Engine 1-1 Valve Test				
Valve Open Ind (Closed) (vdc)	0.000			*
Aft Bus 1 Voltage (vdc)	28.118			*
Valve Open Ind (Open) (vdc)	4.020			*

APS 1 - Engine Propellant Transfer Valve Tests

Valve Movement	Time (sec)	Valve Open Ind (vdc)	Measured Pressures (psia) Thrust Chamb	Oxid Manif	Fuel Manif
Engine 1-2					
Open	0.000	-0.005	14.830	34.914	31.858
	0.022	0.230	14.618	34.478	31.858
	0.057	4.040	24.158	32.295	31.858
	0.090	4.076	28.186	32.295	31.858
	0.123	4.051	28.609	32.295	27.931
Close	0.021	2.051	27.762	29.676	27.931
	0.057	0.000	22.886	29.676	27.059
	0.093	0.000	18.435	29.676	27.059
	0.130	-0.005	15.891	29.676	26.622
	0.163	0.000	15.042	29.240	26.622
Engine 1-3					
Open	0.000	-0.005	14.781	32.731	30.550
	0.023	0.246	14.993	33.168	30.550
	0.061	3.938	25.377	33.168	30.550
	0.095	3.974	27.920	29.240	27.931
	0.129	3.989	27.708	29.240	27.931
Close	0.021	3.974	27.072	27.931	26.186
	0.005	0.005	22.622	27.931	26.186
	0.089	0.000	18.808	27.931	26.186
	0.124	-0.005	16.265	27.931	26.186
	0.160	0.000	14.993	27.931	26.186
Engine 1-1					
Open	0.000	0.000	14.840	32.295	30.550
	0.021	0.000	14.629	32.731	30.113
	0.056	3.953	23.725	31.423	30.113
	0.090	4.005	26.898	31.423	30.113
	0.123	4.020	27.109	29.240	27.059
Close	0.024	4.020	26.264	29.240	27.059
	0.061	0.000	19.917	27.931	25.312
	0.094	-0.005	16.144	27.931	25.312
	0.128	0.005	15.052	27.931	24.749
	0.162	0.000	14.417	27.931	24.749

* Limits Not Specified

4.3.20.1 (Continued)

APS 2 Test

Function	Meas.	AO Multi	BO Multi	Limit
IU Substitute Power (vdc)	-29.92			-28.5 ± 2.5
Helium Sphere Pressure (psia)		34.4	34.4	100.0 max
Helium Regulator Outlet (psia)		44.1	44.1	50.0 ± 10.0
Helium Sphere Temperature (°F)		76.6	-	*
Oxidizer Tank Temperature (°F)		70.7	70.7	*
Fuel Tank Temperature (°F)		70.3	70.2	*
Fuel Tank Ullage Pressure (psia)		45.0	-	50.0 ± 10.00
Oxidizer Tank Ullage Pressure (psia)		39.71 †	-	50.0 ± 10.00
Fuel Manifold Pressure (psia)		31.9	-	40.0 ± 20.00
Oxidizer Manifold Pressure (psia)		33.2	-	40.0 ± 20.00
Engine 2-2 Valve Test				
Valve Open Ind (Closed) (vdc)	0.00			*
Aft Bus 1 Voltage (vdc)	28.278			*
Valve Open Ind (Open) (vdc)	3.948			*
Engine 2-3 Valve Test				
Valve Open Ind (Closed) (vdc)	-0.010			*
Aft Bus 1 Voltage (vdc)	28.399			*
Valve Open Ind (Open) (vdc)	3.887			*
Engine 2-1 Valve Test				
Valve Open Ind (Closed) (vdc)	0.000			*
Aft Bus 1 Voltage (vdc)	28.438			*
Valve Open Ind (Open) (vdc)	3.938			*

APS 2 - Engine Propellant Transfer Valve Tests

			Measured Pressures (psia)		
Valve Movement	Time (sec)	Valve Open Ind (vdc)	Thrust Chamb	Oxid Manif	Fuel Manif
Engine 2-2					
Open	0.000	-0.005	14.807	32.731	31.423
	0.021	0.000	14.807	32.731	31.423
	0.056	3.928	25.407	32.295	31.858
	0.090	3.948	27.951	32.295	31.858
	0.123	3.953	28.163	29.240	31.858
Close	0.021	3.917	27.314	29.240	28.367
	0.056	0.000	22.227	27.494	28.367
	0.092	0.000	18.411	27.494	27.931
	0.129	-0.005	16.291	27.494	27.931
	0.163	0.000	15.020	27.931	28.367

* Limits Not Specified

† See Revision "e"

4.3.20.1 (Continued)

Valve Movement	Time (sec)	Valve Open Ind (vdc)	Measured Pressures (psia) Thrust Chamb	Oxid Manif	Fuel Manif
Engine 2-3					
Open	0.000	0.000	14.634	30.986	30.113
	0.022	0.056	14.634	31.423	30.113
	0.057	3.871	24.604	30.550	30.550
	0.092	3.943	27.360	30.550	30.550
	0.128	3.923	27.360	27.931	30.550
Close	0.022	1.805	26.937	27.931	28.367
	0.055	0.000	22.270	27.494	28.367
	0.089	0.000	18.876	27.494	27.931
	0.123	-0.005	16.331	27.494	27.931
	0.156	0.000	15.059	27.931	27.494
Engine 2-1					
Open	0.000	-0.005	14.565	31.423	30.550
	0.021	0.082	14.776	30.986	30.550
	0.056	3.943	24.484	30.986	30.113
	0.090	3.948	27.229	30.986	30.113
	0.123	3.938	27.439	28.367	28.804
Close	0.023	3.835	26.384	28.367	28.804
	0.061	0.000	21.319	27.059	27.059
	0.095	-0.005	17.942	27.059	27.059
	0.128	0.000	16.043	26.186	27.059
	0.161	-0.010	14.776	26.186	27.059

Ullage Engine Tests

Function	Measurement	Limit
IU Substitute Power (vdc)	-28.00	-28.5 ± 2.5
APS 1 Fuel Supply Manifold Pressure (psia)	35.4	40.0 ± 20.0
APS 1 Oxidizer Supply Manifold Pressure (psia)	36.7	40.0 ± 20.0
APS 2 Fuel Supply Manifold Pressure (psia)	35.4	40.0 ± 20.0
APS 2 Oxidizer Supply Manifold Pressure (psia)	34.0	40.0 ± 20.0

Ullage Engine Propellant Transfer Valve Test

Valve Movement	Time (sec)	Measured Pressures (psia) Thrust Chamb	Oxid Manif	Fuel Manif
APS 1 - Engine 1-4				
Open	0.000	14.725	36.224	34.914
	0.030	14.725	36.224	34.914
	0.073	14.725	36.224	34.914
	0.116	23.454	33.604	31.423
	0.160	23.454	33.604	31.423
	0.205	20.899	30.986	28.804

4.3.20.1 (Continued)

Ullage Engine Propellant Transfer Valve Test

Valve Movement	Time (sec)	Measured Pressures (psia) Thrust Chamb	Oxid Manif	Fuel Manif
Close	0.030	20.048	29.240	26.622
	0.073	19.195	27.059	25.749
	0.117	19.195	27.059	25.749
	0.160	14.725	27.931	25.312
	0.205	14.298	27.931	25.312
APS 2 - Engine 2-4				
Open	0.000	14.699	34.042	34.478
	0.030	14.912	34.042	34.478
	0.073	14.699	34.042	34.478
	0.116	14.699	34.478	34.914
	0.160	14.912	34.478	34.914
	0.205	14.912	33.168	34.914
Close	0.030	14.699	33.604	34.914
	0.073	14.499	33.604	34.478
	0.117	14.912	30.604	34.478
	0.160	14.912	34.042	34.042
	0.205	14.699	34.042	34.042

4.3.21 Hydraulic System (1B55824 F)

This automatic procedure verified the integrity of the stage hydraulic system and demonstrated the capability of the system to provide engine centering and control during powered flight. The test involved all components of the stage hydraulic system, including the main hydraulic pump, P/N 1A66240-503, S/N X457808; the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454588; the accumulator/reservoir assembly, P/N 1B29319-519, S/N 34; the hydraulic pitch actuator, P/N 1A66248-505, S/N 51; and the hydraulic yaw actuator, P/N 1A66248-505, S/N 53.

The test was initially conducted on 14 May 1968, and repeated on 15 May 1968, to verify that the digital data tape (DDT) coefficient changes for the pitch and yaw actuator position parameters corrected the out-of-tolerance measurements recorded during the initial test. Those function values measured during the second test are presented in Test Data Table 4.3.21.1 All of these values were acceptable and were within general design requirements, although specific limit requirements were not defined in the procedure for most of the measurements.

The stage power setup, H&CO 1B55813, was accomplished, and initial conditions were established for the test. The instrument unit (IU) substitute 5 volt power supply was turned on, its voltage was measured, and the aft 5 volt excitation module voltage was measured. Measurements were made of various hydraulic system functions with the hydraulic system unpressurized. Measurements were also made to determine the accumulator/reservoir gaseous nitrogen mass and corrected oil level.

4.3.21 (Continued)

The methods of controlling the auxiliary hydraulic pump were checked next. After verifying that a power cable was connected to the auxiliary hydraulic pump motor, the aft bus 2 power supply was turned on, and the bus voltage was verified to be 56.0 $\pm$4.0 vdc. The coast mode operation was checked by applying dry ice to the coast mode thermal switch, and by verifying that the low temperature caused the thermal switch to turn the auxiliary pump on when the auxiliary hydraulic pump coast command was turned on. The dry ice was removed, and it was verified that the increased temperature caused the thermal switch to turn the pump off. The coast command and the aft bus 2 power supply were turned off, and the bus voltage was verified to be 0.0 $\pm$1.0 vdc. During the remaining pump control checks, only the auxiliary hydraulic pump motor ON indication was checked, as the pump did not run while the aft bus 2 power was off. The flight mode operation was checked by verifying that turning the auxiliary hydraulic pump flight command on and off properly turned the axuiliary pump on and off. The manual mode operation was checked by verifying that the auxiliary pump could be properly turned on and off at the GSE mechanical systems panel when the GSE was in the manual mode.

The engine centering tests were then conducted. The first test was conducted with the actuator position locks on, and with the hydraulic system unpressurized. The actuator positions and the voltage of the IU substitute 5 volt power supply and the aft 5 volt excitation module were measured, and the corrected actuator positions were determined. The pitch and yaw actuator locks were removed; then, the aft bus 2 power was turned on, and the voltage was measured. The axuiliary hydraulic pump was turned on in the automatic

4.3.21 (Continued)

mode, and the aft bus 2 current was measured. The increase in hydraulic system pressure over a 4 second period was measured and determined to be within tolerance. With the hydraulic system pressurized and no excitation signal applied to the actuator, the second engine centering test was conducted with the actuator locks off. The test measurements were repeated as before, and the corrected actuator positions were again determined. A zero excitation signal was then applied to the actuators, the hydraulic system functions were measured, the actuator position measurements were repeated, and the correct actuator positions were again determined.

A clearance, linearity, and polarity check was accomplished next. The actuators were individually extended to their stops, then retracted, causing the engine to move out to its extremes of travel, 0 degrees to ± 7 1/2 degrees, in a square pattern, counterclockwise as viewed from the engine bell. The engine was then returned to its 0 degree centered position. As the engine was sequenced through the square pattern, a clearance check verified that there was no interference to engine motion within the gimbal envelope. A comparison of the hydraulic servo engine positioning system command and response signals verified that the response movement was of the correct polarity and magnitude to agree with the command signal, and met the requirements for movement linearity. Checks of the hydraulic system pressure and reservoir oil pressure, when the actuators were at their extreme and when they were returned to neutral, verified that these pressures remained acceptable.

Transient response tests were conducted next. Step commands were separately applied to the pitch and yaw actuators, causing each actuator to individually

4.3.21 (Continued)

move the engine from 0 degrees to -3 degrees, from -3 degrees to 0 degrees, from 0 degrees to +3 degrees, and from +3 degrees to 0 degrees. The engine response was observed visually and audibly for unwanted oscillations, and the actuator responses were recorded during the engine movement. The engine slew rates were computed for each of the step movements. The test data table shows the computed slew rates and representative actuator response values for the initial period of each check. The values measured were all acceptable and within general design requirements, although specific limits were not discernible from the procedure.

After the transient response test was completed, final measurements were made of the hydraulic system functions and the engine centering functions with the hydraulic system pressurized, the actuator locks off, and no excitation signals applied to the actuators.

The procedure was completed by turning off the auxiliary hydraulic pump, aft bus 2, and the IU substitute 5 volt power supply. The pitch and yaw actuator locks were then replaced.

Engineering comments noted that all parts were installed during the tests. No major problems were encountered during the second test; however, auxiliary hydraulic pump motor gas pressure, measurement D0209, was out-of-tolerance and was rejected on FARR 500-226-307. Records of previous testing reflected gradual increase for this parameter, finally exceeding the maximum limit. Investigation resulted in replacement of the auxiliary hydraulic pump motor gas pressure regulator. The new regulator was functionally tested and checked satisfactorily with measurement D0209 within the allowable limits.

4.3.21 (Continued)

Twenty-one revisions were recorded in the procedure for the two tests for the following:

a. One revision authorized the second test on 15 May 1968, to repeat the procedure as described previously.

b. Three revisions entered the DDT coefficient changes into the program that were needed for the second test.

c. One revision modified the procedure to require retaining the lineprinter and typewrite test results for stage power setup or initial conditions scan conducted prior to the hydraulic system test.

d. One revision updated the procedure based on the most recently established hydraulic system tolerances.

e. One revision authorized manual recording of auxiliary hydraulic pump motor gas pressure and auxiliary hydraulic pump air tank pressure (measurements D0209 and D0223) prior to, during, and after operation of the pump.

f. One revision added new measurement D0248, cold helium sphere pressure, to the DDT.

g. Nine revisions corrected program errors.

h. Two revisions corrected procedure errors.

i. One revision explained an out-of-tolerance aft bus 2 voltage measurement that occurred due to operator error. The repeat measurement was within tolerance.

j. One revision concerned a malfunction of the GSE system status display (SSD) which did not affect the hydraulic system.

4.3.21.1 Test Data Table, Hydraulic System

Function	Measurement	Limits
IU Substitute 5 volt Power Supply (vdc)	5.00	5.00 ± 0.05
Aft 5 Volt Excitation Module (vdc)	4.99	5.00 ± 0.05

4.3.21.1 (Continued)

Function	Measurement	Limits
Hydraulic System Unpressurized		
Reservoir Oil Pressure (psia)	85.54	*
Accumulator GN_2 Pressure (psia)	2361.94	*
Accumulator GN_2 Temperature (^oF)	73.31	*
Reservoir Oil Level (%)	91.60	*
Pump Inlet Oil Temperature (^oF)	71.75	*
Reservoir Oil Temperature (^oF)	72.92	*
Aft Bus 2 Current (amp)	0.20	*
Gaseous Nitrogen Mass (lb)	1.915	1.925 $\pm$ 0.2
Corrected Reservoir Oil Level (%)	101.6	95.0 min
Engine Centering Test, Locks On, System Unpressurized		
T/M Pitch Actuator Position (deg)	-0.02	*
IU Pitch Actuator Position (deg)	-0.01	*
T/M Yaw Actuator Position (deg)	-0.01	*
IU Yaw Actuator Position (deg)	0.06	*
IU Substitute 5 Volt Power Supply (vdc)	5.00	*
Aft 5 Volt Excitation Module (vdc)	4.99	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	0.05	*
Corrected T/M Pitch Actuator Position (deg)	-0.026	-0.236 to 0.236
Corrected IU Pitch Actuator Position (deg)	-0.015	-0.236 to 0.236
Corrected T/M Yaw Actuator Position (deg)	-0.006	-0.236 to 0.236
Corrected IU Yaw Actuator Position (deg)	0.059	-0.236 to 0.236
Engine Centering Test, Locks Off, System Pressurized No Excitation Signal		
Aft Bus 2 Voltage (vdc)	56.24	56.0 $\pm$ 4.0
Aft Bus 2 Current (amp)	52.80	55.0 $\mp$ 30.0
Hyd System 4 Second Press Change (psia)	255.3	200.0 min
T/M Pitch Actuator Position (deg)	-0.04	*
IU Pitch Actuator Position (deg)	-0.04	*
T/M Yaw Actuator Position (deg)	-0.01	*
IU Yaw Actuator Position (deg)	0.03	*
IU Substitute 5 Volt Power Supply (vdc)	5.01	*
Aft 5 Volt Excitation Module (vdc)	4.99	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	0.00	*
Corrected T/M Pitch Actuator Position (deg)	-0.042	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0.029	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	-0.006	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	0.015	-0.517 to 0.517

* Limits Not Specified

4.3.21.1 (Continued)

Function	Measurement	Limits
Hydraulic System Pressurized, Locks Off, Zero Excitation Signal Applied to Actuators		
Hydraulic System Pressure (psia)	3604.63	*
Reservoir Oil Pressure (psia)	173.26	*
Accumulator GN_2 Pressure (psia)	3594.81	*
Accumulator GN_2 Temperature (^{o}F)	94.89	*
Reservoir Oil Level (%)	40.68	*
Pump Inlet Oil Temperature (^{o}F)	72.93	*
Reservoir Oil Temperature (^{o}F)	73.31	*
Aft Bus 2 Current (amp)	44.80	*
T/M Pitch Actuator Position (deg)	-0.05	*
IU Pitch Actuator Position (deg)	-0.04	*
T/M Yaw Actuator Position (deg)	-0.01	*
IU Yaw Actuator Position (deg)	0.03	*
IU Substitute 5 Volt Power Supply (vdc)	5.00	*
After 5 volt Excitation Module (vdc)	4.99	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	0.05	*
Corrected T/M Pitch Actuator Position (deg)	-0.058	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0.044	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	-0.006	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	0.029	-0.517 to 0.517

Transient Response Tests, Pitch Axis

Time From Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
Pitch 0 to -3 Degree Step Response - Engine Slew Rate: 16.9 deg/sec			
0.000	0.050	-0.073	4.999
0.027	-19.775	-0.577	5.005
0.055	-19.824	-0.980	5.000
0.082	-19.922	-1.428	4.990
0.109	-19.873	-1.933	5.000
0.137	-19.824	-2.366	4.990
0.164	-19.922	-2.712	5.000
0.191	-19.824	-2.929	5.000
0.219	-19.824	-3.059	5.005
0.246	-19.922	-3.102	4.990
0.273	-19.922	-3.116	4.990
0.302	-19.824	-3.102	5.000

* Limits Not Specified

4.3.21.1 (Continued)

Time From Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
Pitch -3 to 0 Degree Step Response - Engine Slew Rate: 16.3 deg/sec			
0.000	-19.899	-3.177	4.994
0.025	0.049	-2.697	5.000
0.053	0.049	-2.309	5.000
0.081	0.000	-1.890	5.000
0.107	0.049	-1.399	4.990
0.136	0.049	-0.952	5.000
0.162	0.000	-0.519	5.000
0.189	0.049	-0.230	5.000
0.218	0.049	-0.071	5.000
0.244	0.049	-0.043	5.005
0.271	0.049	-0.058	5.005
0.300	0.000	-0.058	5.000
Pitch 0 to +3 Degree Step Response - Engine Slew Rate: 16.1 deg/sec			
0.000	0.050	-0.029	5.005
0.025	19.824	0.434	4.990
0.054	19.922	0.809	4.990
0.080	19.824	1.256	4.990
0.107	19.873	1.703	4.990
0.136	19.824	2.180	5.005
0.162	19.824	2.627	5.000
0.189	19.873	2.915	5.000
0.218	19.824	3.060	5.000
0.244	19.824	3.103	5.000
0.272	19.824	3.103	4.990
0.300	19.824	3.074	5.000
Pitch +3 to 0 Degree Step Response - Engine Slew Rate: 16.7 deg/sec			
0.000	19.850	3.132	4.994
0.027	0.049	2.670	5.000
0.057	0.049	2.251	5.000
0.084	0.000	1.775	5.000
0.111	0.000	1.313	5.000
0.139	0.049	0.837	5.000
0.166	0.000	0.477	5.005
0.193	0.000	0.202	5.000
0.221	0.000	0.087	5.005
0.248	0.000	0.059	5.000
0.275	0.049	0.059	5.000
0.302	0.000	0.044	4.990

4.3.21.1 (Continued)

Transient Response Tests, Yaw Axis

Time From Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
Yaw 0 to -3 Degree Step Response - Engine Slew Rate: 15.1 deg/sec			
0.000	0.000	-0.015	4.994
0.028	-19.727	-0.477	5.000
0.059	-19.775	-0.852	5.000
0.086	-19.824	-1.271	5.000
0.112	-19.775	-1.688	5.000
0.141	-19.678	-2.136	4.990
0.168	-19.727	-2.525	5.000
0.194	-19.727	-2.800	5.000
0.223	-19.727	-2.915	4.990
0.250	-19.727	-2.973	5.000
0.276	-19.727	-2.930	4.990
0.305	-19.727	-2.958	4.990
Yaw -3 to 0 Degree Step Response - Engine Slew Rate: 15.9 deg/sec			
0.000	-19.699	-2.999	4.999
0.028	0.049	-2.540	4.990
0.058	0.000	-2.136	5.005
0.086	0.049	-1.703	5.020
0.112	0.000	-1.271	5.000
0.140	0.000	-0.823	4.990
0.168	0.000	-0.448	5.000
0.194	0.049	-0.202	5.005
0.222	-0.049	-0.102	5.000
0.250	0.049	-0.072	5.005
0.276	0.049	-0.044	5.000
0.305	0.049	0.000	5.000
Yaw 0 to +3 Degree Step Response - Engine Slew Rate: 15.0 deg/sec			
0.000	0.050	0.044	4.999
0.026	19.824	0.476	4.990
0.055	19.824	0.822	5.005
0.081	19.824	1.270	5.005
0.108	19.775	1.702	5.000
0.136	19.824	2.149	5.005
0.163	19.824	2.524	4.990
0.190	19.824	2.770	5.005
0.218	19.727	2.914	5.000
0.245	19.824	2.957	5.000
0.273	19.824	2.986	5.005
0.300	19.824	3.001	5.005

4.3.21.1 (Continued)

Time From Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
Yaw +3 to 0 Degree Step Response - Engine Slew Rate: 14.5 deg/sec			
0.000	19.850	3.103	4.994
0.025	0.000	2.626	5.005
0.053	0.049	2.250	5.005
0.081	0.049	1.890	5.000
0.107	0.000	1.442	5.000
0.135	0.000	0.995	4.990
0.163	0.049	0.591	5.000
0.189	0.049	0.288	5.000
0.218	0.049	0.129	5.000
0.245	0.000	0.071	5.000
0.271	0.000	0.058	5.000
0.300	0.049	0.071	4.990

Final Hydraulic System and Engine Centering Test
System Pressurized, Locks Off, No Excitation Signal

Function	Measurement	Limits
Hydraulic System Pressure (psia)	3630.81	*
Reservoir Oil Pressure (psia)	178.50	*
Accumulator GN_2 Pressure (psia)	3630.31	*
Accumulator GN_2 Temperature (°F)	81.94	*
Reservoir Oil Level (%)	41.93	*
Pump Inlet Oil Temperature (°F)	132.73	*
Reservoir Oil Temperature (°F)	118.12	*
Aft Bus 2 Current (amps)	45.20	*
T/M Pitch Actuator Position (deg)	-0.05	*
IU Pitch Actuator Position (deg)	-0.06	*
T/M Yaw Actuator Position (deg)	-0.01	*
IU Yaw Actuator Position (deg)	0.03	*
IU Substitute 5 Volt Power Supply (vdc)	4.99	*
Aft 5 Volt Excitation Module (vdc)	4.99	*
Pitch Actuator Signal (ma)	0.00	*
Yaw Actuator Signal (ma)	0.00	*
Corrected T/M Pitch Actuator Position (deg)	-0.058	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0.065	-0.517 to 0.517
Corrented T/M Yaw Actuator Position (deg)	-0.006	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	0.036	-0.517 to 0.517

* Limits Not Specified

4.3.22 Range Safety Receiver Checks (1B55819 G)

This combined manual and automatic checkout verified the functional capabilities of the range safety receivers and decoders prior to their use in the range safety system. The receivers were checked for automatic gain control (AGC) calibration and drift, minimum acceptable deviation sensitivity, minimum acceptable RF sensitivity, and open loop RF operation. The items involved in this test were:

Item	Ref. Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	172
Range Safety Receiver 2	411A97A18	50M10697	166
Secure Command Decoder 1	411A99A1	50M10698	019
Secure Command Decoder 2	411A99A2	50M10698	091

Initiated on 14 May 1968, this checkout was completed and accepted on the same date.

Several manual operations were accomplished before the automatic phase of the checkout was started. The total cable insertion loss values at the 450 MHz range safety frequency were determined to be 30.0 db for range safety system 1 and 30.0 db for range safety system 2. The destruct system test set, P/N 1A59952-1, was set up at 450 $\pm$0.045 MHz with a -17 dbm output level and a 60 $\pm$0.60 kHz deviation. The stage range safety antennas were disconnected from the directional power divider; and until the open loop RF checks, the 50 ohm loads were connected to the power divider for testing.

The cable insertion loss values were loaded into the computer, initial test conditions were established, the range safety receivers were transferred to external power and turned on, and the propellant dispersion cutoff command inhibit was turned on.

4.3.22 (Continued)

The receiver AGC calibration checks were conducted next. For each input signal level used in the calibration check, the computer determined the GSE test set output levels required to compensate for the cable insertion loss. Per the computer typeout, the GSE test set was manually adjusted to the appropriate output levels. The computer determined the input signal levels and measured the low level signal strength (AGC telemetry) of each receiver. These AGC measurements, in the 0.0 to 5.0 vdc range, were multiplied by a conversion factor of 20 and presented as per cent of full scale values. The difference in AGC values at each step was determined and utilized for the AGC drift check. As shown in Test Data Table 4.3.22.1, the AGC values were all acceptable; and the drift deviations were well below the 3 per cent of full scale maximum limit.

Manual -3 db and -60 db RF bandwidth checks were individually conducted on each receiver. With a GSE test set output frequency of 450.000 $\pm$0.005 MHz, the output level was adjusted to obtain a 2.0 $\pm$0.1 vdc AGC voltage from the receiver under test. The corresponding receiver RF output level was determined, and +20 dbm was added to obtain the RF reference level. Until the receiver AGC voltage was again 2.0 $\pm$0.1 vdc, the GSE test set output level was increased by 3 db; and the test set frequency was increased to greater than 450 MHz and decreased to less than 450 MHz. The frequencies at which this occurred were measured as the upper and lower -3 db band edge frequencies. The -3 db bandwidth was found as the difference between these frequencies, and the bandwidth centering was found as the difference between the midpoint of these frequencies and 450 MHz. For the -60 db bandwidth check, this checkout was repeated, except that the test set output level was increased by 60 db in lieu of 3 db.

4.3.22 (Continued)

For the deviation threshold check, the GSE test set was adjusted to an output of 450 $\pm$0.045 MHz at a level that provided receiver input levels of -63 dbm for receivers 1 and 2. A series of checks determined the minimum input deviation frequency at which each receiver responded to the respective range safety command. For each command, the GSE test set was manually adjusted to a sequence of deviation frequencies increasing from 5 kHz, per the computer typeout. At each deviation frequency, the range safety secure command decoders were checked for the presence of the command signal from the appropriate receiver. As shown in the Test Data Table, the receivers responded to all commands at minimum deviation frequencies less than the 50 kHz maximum limit.

For the radio frequency sensitivity checks, the GSE test set was adjusted for an output of 450 $\pm$0.045 MHz with a fixed deviation of 60 $\pm$0.5 kHz. A series of checks determined the minimum input signal level at which each receiver responded to the respective range safety commands. For each command, the GSE test set output was manually adjusted to a sequence of levels increasing from -85.5 dbm, as requested by the computer. This gave input levels increasing from -115.0 dbm for receivers 1 and 2. At each input level, the range safety secure command decoders were checked for receipt of the command signal from the appropriate receiver. Both receivers responded to minimum input levels at less than the -93 dbm maximum limit.

The 50 ohm loads were disconnected from the stage power divider, and the range safety antennas were reconnected. For the manual open loop check, the GSE test set was adjusted for open loop operation; and the test set antenna coaxial switch was set to test position 1. The test set output level was set at -100 dbm and increased in 1 dbm increments until the AGC voltage of the least sensitive receiver no longer increased. This occurred at an output level of -81 dbm. The AGC voltage of the other receiver was verified to be within 3 vdc of this level. The check was repeated with the test set antenna coaxial switch set to test position 2 with the output level measured as -79 dbm. The test set antenna coaxial switch was returned to the first test position, and the test set output level was set at -86.0 dbm for the automatic open loop RF checks.

Under open loop conditions, the low level signal strength (AGC telemetry voltage) of receiver 1 was 3.45 vdc, while that of receiver 2 was 3.68 vdc. The range safety commands were transmitted from the GSE test set, and checks of the secure command decoders indicated the receivers responded properly to the open loop transmission. The PCM RF assembly power was turned on, the open loop PCM signal was verified to be received at the DDAS ground station, and the range safety commands were again transmitted. Checks of the decoders indicated that the receivers responded and were not adversely affected by the PCM RF transmission. The PCM RF assembly power was turned off, and the range safety EBW firing units were transferred to external power. The propellant dispersion cutoff command inhibits were turned off for each receiver; and the range safety receivers were turned off, thus completing the range safety receiver checks.

Engineering comments noted that there were no part shortages affecting the test, and no problems were encountered that resulted in a FARR.

4.3.22 (Continued)

One revision was documented against the checkout to delete the posttest shutdown instructions, as the equipment is required to be on for the next procedure.

4.3.22.1 Test Data Table, Range Safety Receiver Checks

AGC Calibration and Drift Checks (% = Per Cent of Full Scale)

Test Set Output (dbm)	Receiver 1 Input (dbm)	AGC 1 (%) Run 1	AGC 1 (%) Run 2	AGC 1 (%) Drift	Receiver 2 Input (dbm)	AGC 2 (%) Run 1	AGC 2 (%) Run 2	AGC 2 (%) Drift
-97.0	-127.0	17.42	17.01	0.41	-127.0	18.75	19.60	0.31
-90.0	-120.0	17.52	17.73	0.21	-120.0	18.96	19.28	0.31
-85.0	-115.0	18.14	17.83	0.31	-115.0	19.69	19.38	0.31
-80.0	-110.0	19.47	19.16	0.31	-110.0	20.70	21.11	0.41
-75.0	-105.0	23.07	22.34	0.72	-105.0	25.21	25.02	0.20
-70.0	-100.0	32.09	32.60	0.51	-100.0	35.68	34.77	0.92
-65.0	- 95.0	51.58	51.48	0.10	- 95.0	55.68	55.18	0.51
-60.0	- 90.0	68.20	68.09	0.12	- 90.0	72.40	72.30	0.10
-55.0	- 85.0	70.96	70.96	0.00	- 85.0	75.37	75.37	0.00
-50.0	- 80.0	71.37	71.58	0.21	- 80.0	76.00	76.09	0.10
-45.0	- 75.0	71.68	71.68	0.00	- 75.0	76.50	76.50	0.00
-40.0	- 70.0	71.78	71.68	0.10	- 70.0	76.60	76.70	0.10

-3 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC) (vdc)	2.01	2.00	2.0 ± 0.1
Reference RF Power Level (dbm)	-67.3	-68.0	-
Upper Band Edge Freq. (MHz)	450.147	450.161	-
Lower Band Edge Freq. (MHz)	449.833	449.831	-
-3 db Bandwidth (kHz)	314.0	330.0	340.0 ± 30.0
Bandwidth Centering (MHz)	449.990	449.996	450.0 ± 0.0338

-60 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC) (vdc)	2.01	2.00	2.0 ± 0.1
Reference RF Power Level (dbm)	-67.3	-68.0	-
Upper Band Edge Freq. (MHz)	450.490	450.556	-
Lower Band Edge Freq. (MHz)	449.528	449.542	-
-60 db Bandwidth (MHz)	.962	1.014	1.2 max

4.3.22.1 (Continued)

Deviation Sensitivity Check

Range Safety Command	Minimum Deviation (kHz) Receiver 1	Receiver 2
Arm and Engine Cutoff	15.0	12.5
Propellant Dispersion	17.5	12.5
Range Safety System Off	17.5	12.5

RF Sensitivity Check

Range Safety Command	Minimum Input Level (dbm) Receiver 1	Receiver 2
Arm and Engine Cutoff	-100.0	-100.0
Propellant Dispersion	-100.0	-100.0
Range Safety System Off	-100.0	-105.0

4.3.23 Range Safety System (1B55821 H)

The automatic checkout of the range safety system verified the system external/internal power transfer capability, and the capability of the system to respond to the propellant dispersion inhibit and trigger commands, the engine cutoff command, and the system off command. The items involved in this test included the following:

Part Name	Reference Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	172
Range Safety Receiver 2	411A97A18	50M10697	166
Secure Command Decoder 1	411A99A1	50M10698	019
Secure Command Decoder 2	411A99A2	50M10698	091
Secure Command Controller 1	411A97A13	1B33084-503	014
Secure Command Controller 2	411A97A19	1B33084-503	013
RS System 1 EBW Firing Unit	411A99A12	40M39515-119	451
RS System 2 EBW Firing Unit	411A99A20	40M39515-119	450
RS System 1 EBW Pulse Sensor	411A99A31	40M02852	*
RS System 2 EBW Pulse Sensor	411A99A32	40M02852	*
Safe and Arm Device	411A99A22*	1A02446-503	00005
Directional Power Divider	411A97A56	1B38999-1	033
Hybrid Power Divider	411A97A34	1A74778-501	041
* Installed in Pulse Sensor Assembly	411A99A31/A32	1B29054-501	00006

This procedure was initiated on 14 May 1968, and was accomplished by the second attempt on 15 May 1968. The second attempt was required because the O_2H_2 burner shutdown responses were not properly performed. Values measured during the test are shown in Test Data Table 4.3.23.1. Initial conditions were established for the test, and the GSE destruct system test set, P/N 1A59952-1, was set up for closed loop operation at 450 MHz with a -50 dbm output level and a 60 kHz deviation. The forward bus 1 and bus 2 battery simulators were turned on, both receivers were verified to be off, and the battery simulator voltages were measured.

4.3.23 (Continued)

The external/internal power transfer test was then started. Both EBW firing units were verified to be off, and external power was turned on for both receivers and both firing units. The firing unit charging voltage indications and the firing unit indications were measured for both range safety systems. The propellant dispersion cutoff command inhibit was then turned on for both receivers. Both firing units were transferred to internal power, and the external power for the units was turned off. Both units were verified to be on, and the charging voltage indications were measured. Both firing units were transferred back to external power and verified to be off, and the firing unit charging voltage indications were again measured. The external power for both receivers was turned off, and the receivers were verified to be off. The receivers were transferred to internal power and verified to be on, then transferred back to external power and verified to be off. Finally, both receivers were transferred back to internal power and again verified to be on.

The EBW firing unit arm and engine cutoff test was conducted next. The engine control bus power was turned on, the bus voltage was measured, and the low level signal strength indications were measured for both receivers. The EBW firing unit arm and engine cutoff command was turned on and verified to be received by range safety system 1. The system 1 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were off at the umbilical and through the AO and BO telemetry multiplexers, that the nonprogrammed engine cutoff indication was off, and that the instrument unit receiver 1 arm and engine cutoff indication was off. The receiver 1 propellant dispersion cutoff command inhibit was then turned off, and

4.3.23 (Continued)

the instrument unit receiver 2 arm and engine cutoff indication was verified to be off. Verification was made that the engine control bus power was then off, that the engine cutoff indications were still off at the umbilical and through both multiplexers, that the nonprogrammed engine cutoff indication was still off, and that the instrument unit receiver 1 arm and engine cutoff indication was then on. The receiver 1 propellant dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 1 arm and engine cutoff indication was verified to again be off. The EBW firing unit arm and engine cutoff command was turned off. The engine control bus power was turned back on, and the bus voltage was measured. Both firing units were transferred to external power and verified to be off, and the charging voltage indications were measured.

The EBW firing unit arm and engine cutoff command was turned back on and verified to be received by range safety system 2. The system 2 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were off at the umbilical and through the AO and BO telemetry multiplexers, that the nonprogrammed engine cutoff indication was off, and that the instrument unit receiver 2 arm and engine cutoff indication was off. The receiver 2 propellant dispersion cutoff command inhibit was turned off, and the instrument unit receiver 1 arm and engine cutoff indication was verified to be off. Verification was made that the engine control bus power was still on, that the engine cutoff indication was then on at the umbilical and through both multiplexers, that the nonprogrammed engine cutoff indication was then on, and that the instrument unit receiver 2 arm and engine cutoff indication was on. The receiver 2 propellant dispersion cutoff command inhibit was

4.3.23 (Continued)

turned back on, and the instrument unit receiver 2 arm and engine cutoff indication was verified to again be off. The EBW firing unit arm and engine cutoff command was turned off. The engine ready bypass was turned on, and the engine cutoff indication was verified to be off at the umbilical.

The EBW pulse sensor power and pulse sensor self-test were turned on, and both range safety pulse sensors were verified to be set. The pulse sensor reset was turned on, and both pulse sensors were verified to be reset. Each of the range safety systems was individually tested by the following steps, starting with system 1. The propellant dispersion command was turned on and verified to be received by the receiver under test. The appropriate firing unit charging voltage indication was measured, and the appropriate pulse sensor was verified to be off. The propellant dispersion command was turned off, the propellant dispersion cutoff command inhibit for the receiver under test was turned off, and the propellant dispersion command was turned back on. For the system under test, the firing unit charging voltage indication was measured; and the pulse sensor was verified to be on. The propellant dispersion cutoff command inhibit was then turned back on, and the propellant dispersion command was turned off. The above steps were then repeated to test system 2. After the test of system 2, the propellant dispersion cutoff command inhibit was turned off for both receivers, and the engine control bus power was verified to be off.

The range safety system off test was conducted next. The range safety system off command was turned on, and power for receiver 1 and the system 1 EBW firing

4.3.23 (Continued)

unit was verified to be off. The range safety system off command was turned off, receiver 2 was transferred to internal power, the range safety system off command was turned back on, and the power for receiver 2 and the system 2 EBW firing unit was verified to be off. The range safety system off command was then turned back off.

The safe and arm device was tested next. The safe-arm safe command was turned on, the safe indication was verified to be on, and the arm indication was verified to be off. The safe-arm arm command was turned on, the safe indication was verified to be off, and the arm indication was verified to be on. The safe-arm safe command was turned back on, and again the safe indication was verified to be on, and the arm indication was verified to be off. This completed the range safety system tests, and the shutdown operations were accomplished.

Engineering comments noted that there were no part shortages affecting this test. No problems were encountered during the second performance of the test, and no FARR's were written. Three revisions were made to the procedure for the following:

a. One revision outlined a special test, and set break points in the program to verify response of the O_2H_2 burner shutdown valve to the "range safety firing unit arm and engine cutoff" command. This revision was subsequently voided.

b. One revision outlined a corrected test sequence for the O_2H_2 burner shutdown valve response test and authorized the rerunning of the entire procedure.

c. One revision deleted the first revision, as the break points were incorrectly stated.

4.3.23.1 Test Data Table, Range Safety System

Function	Measured Value (vdc)	Limits (vdc)
Forward Bus 1 Battery Simulator	28.278	28.0 ± 2.0
Forward Bus 2 Battery Simulator	28.079	29.0 ± 2.0
External/Internal Power Transfer Test		
External Power On		
System 1 Charging Voltage Indication	4.164	4.2 ± 0.3
System 1 Firing Unit Indication	4.163	4.2 ± 0.3
System 2 Charging Voltage Indication	4.274	4.2 ± 0.3
System 2 Firing Unit Indication	4.271	4.2 ± 0.3
Internal Power		
System 1 Charging Voltage Indication	4.169	4.2 ± 0.3
System 2 Charging Voltage Indication	4.279	4.2 ± 0.3
External Power Off		
System 1 Charging Voltage Indication	0.034	0.3 max
System 2 Charging Voltage Indication	0.045	0.3 max
Firing Unit Arm and Engine Cutoff Test		
Engine Control Bus Voltage	27.938	28.0 ± 2.0
Receiver 1 Signal Strength Indication	3.548	3.75 ± 1.25
Receiver 2 Signal Strength Indication	3.773	3.75 ± 1.25
System 1 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.164	4.2 ± 0.3
Engine Control Bus Voltage	28.000	28.0 ± 2.0
External Power Off		
System 1 Charging Voltage Indication	0.039	0.3 max
System 2 Charging Voltage Indication	0.050	0.3 max
System 2 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.284	4.2 ± 0.3

4.3.23.1 (Continued)

Function	Measured Value (vdc)	Limits (vdc)
Propellant Dispersion Test		
System 1 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4.185	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On)	1.800	3.0 max
System 2 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4.284	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On)	1.784	3.0 max

4.3.24 Level Sensor and Control Unit Calibration (1B44473 D)

This manual procedure determined that the control units associated with the LOX and LH_2 liquid level, point level, fast fill, and overfill sensors were adjusted for operating points within the design calibration limits. The particular items involved in this test are noted in Test Data Table 4.3.24.1. The procedure was initiated on 28 May 1968, and was accepted on 31 May 1968.

A point level sensor manual checkout assembly, P/N 1B50928-1, and a variable precision capacitor, General Radio Type 1422CD, were connected in parallel with the sensor to provide capacitance changes to the control unit to simulate sensor wet conditions for calibrations and to establish the control unit operating points. The calibration capacitance was 1.1 $\pm$0.02 picofarads for the LH_2 overfill sensor. With the control unit power turned on, the control unit control point adjustment R1 was adjusted until the control unit output signal changed from 0 $\pm$1 vdc to 28 $\pm$2 vdc, indicating activation of the control unit output relay. The capacitance of the precision capacitor was then decreased until the control unit output signal changed to 0 $\pm$1 vdc, indicating deactivation of the control unit output relay, and then increased until the output signal changed back to 28 $\pm$2 vdc, indicating reactivation of the output relay. The deactivation and reactivation capacitance values were recorded in Test Data Table 4.3.24.1 with the appropriate minimum and maximum capacitance limits.

A series of checks then verified the operation of the output relay test function. With the associated sensor disconnected, the control unit output relay was verified to be deactivated under both normal and test conditions. With the sensor connected, the relay was verified to be deactivated under normal conditions and activated under test conditions.

4.3.24 (Continued)

There were no parts shortages that affected this test. No problems were encountered during the test, nor were any FARR's written. Four revisions were made to the procedure for the following:

a. One revision performed the fuel tank overfill sensor calibration section and deleted all other sections of the procedure.

b. One revision reran the fuel tank overfill sensor calibration procedure to reset the overfill sensor system to a higher capacitance trigger level.

c. Two revisions provided the procedure to verify proper operation of the fuel tank overfill sensor circuit after calibration. During calibration, several cables were disconnected and system revalidation was required.

4.3.24.1 Test Data Table, Level Sensor and Control Unit Calibration

	Sensor			Control Unit P/N 1A68710			Deactivate Cap (pf)		Reactivate Cap (pf)	
Function	Ref. Loc.	Dash P/N	S/N	Ref. Loc.	Dash P/N	S/N	Meas	Min	Meas	Max
LH_2 Tank	408			411						
Overfill	A1	*	*	A92A24	-509	D116	1.079	0.9	1.087	1.3

* Part of LH_2 Mass Probe, P/N 1A48431-509, S/N D4, Location 408A1

4.3.25 <u>All Systems Test (1B55833 G)</u>

After the completion of individual system checkouts for the stage during post-storage and coldflow operations, the all systems test (AST) was conducted to demonstrate the combined operation of the stage electrical, hydraulic, propulsion, instrumentation, and telemetry systems under simulated flight conditions. The test procedure followed, as closely as possible, the actual flight sequence of prelaunch operations, simulated liftoff, ullage firing, engine start, hydraulic gimballing, engine cutoff, coast period, engine restart and cutoff, attitude control, and stage shutdown.

The AST was conducted twice--first with the umbilicals in, then with the umbilicals out. During the umbilicals-in test, the umbilical cables were connected to permit monitoring of talkback during test and to provide complete stage control for troubleshooting and safing operations. During the umbilicals-out test, the umbilicals were ejected at simulated liftoff to verify the proper operation of all on-board systems with the umbilicals disconnected. After completion of the AST, the umbilicals were reconnected, and the stage power turnoff was executed to return the stage to the pretest configuration.

The AST was performed three times during the coldflow and poststorage operations. The first issue was initiated on 5 June 1968, and accepted on the same date. The second issue required two attempts, on 12 June 1968 and 13 June 1968. The first attempt of the second issue was unsuccessful due to erratic operation of the PCM RF transmitter, as reported on FARR 500-225-271. The second attempt was successful, and the AST was acceptable on 14 June 1968.

4.3.25 (Continued)

After accomplishing the various manual electrical and propulsion system setups, automatic testing started with a performance of the stage power setup to establish initial conditions. During the power setup, power was turned on to the propellant utilization (PU) inverter and electronics assembly, the EBW pulse sensors, the engine control and ignition buses, the APS buses, and aft bus 2. The various currents and voltages were measured as listed in the power setup portion of Test Data Table 4.3.25.1. The EBW ullage rocket firing unit disable command and the propellant dispersion cutoff command inhibit for the range safety receivers were turned on. The proper operation of the switch selector was verified during the umbilicals-in test. The power turnon to the PCM RF group and a transmitter warm-up completed the stage power setup for the AST.

The manual setup of the propulsion system was verified, the propulsion system initial conditions were established, and the various helium supply pressures were measured. The LOX chilldown pump purge and engine pump purge sequences were then accomplished.

The next series of prelaunch checks verified that the LOX and LH_2 tank vent valves and fill and drain valves opened properly on command, and that the LOX and LH_2 point level sensors, fastfill sensors, and overfill sensors responded properly to simulated wet conditions. The simulated wet conditions were left on for all, except the overfill sensors, to simulate loaded propellant tanks. The proper operation of the LOX and LH_2 chilldown shutoff valves, prevalves, and vent valves was verified, and the LOX and LH_2 tank prepressurization

4.3.25 (Continued)

sequences were accomplished. The LH_2 pressure control module pressure (D104) was measured during the last sequence. The LOX and LH_2 fill and drain valves were then closed, the proper operation of the LH_2 directional vent valve was verified, and the valve was set to the ground position.

The EBW and telemetry prelaunch checks were conducted next. A pulse sensor self test verified the proper operation of the ullage rocket and range safety EBW firing unit pulse sensors. During the umbilicals-in test only, a check verified that the telemetry RF silence command properly turned off the PCM RF assembly. During both tests, a telemetry calibration and a RACS calibration were accomplished. The PCM/FM transmitter RF power was measured, as was the telemetry antenna 1 forward power. The telemetry RF system reflected power was measured, and the telemetry system closed loop VSWR was determined. Measurements were also made of the static inverter-converter output voltages and operating frequency. During the umbilicals-in test only, the engine cutoff and the nonprogrammed engine cutoff indications were both verified to be off; however, during the umbilicals-out test only, the engine cutoff command was turned on and only the nonprogrammed engine cutoff indication was verified to be off.

The hydraulic system prelaunch checks were conducted next. The pitch and yaw actuator locks were removed, the hydraulic reservoir gaseous nitrogen mass and corrected oil level were measured, and the hydraulic system functions were measured with the hydraulic system unpressurized. The auxiliary hydraulic pump was then turned on to pressurize the system. The system pressure increase over

4.3.25 (Continued)

a 4-second period was measured, and the hydraulic system functions were re-measured with the system pressurized. During the umbilicals-in test only, the 7.5 degree square gimbal pattern check was then satisfactorily accomplished, after which the hydraulic system was depressurized by the auxiliary hydraulic pump shutdown.

The stage and GSE were then set for open loop telemetry operation by turning on the RF distribution system 2 and setting the PCM ground station for open loop reception. A flow rate and turbine speed (FRATS) calibration then measured the reference indication voltages for the LOX and LH_2 circulation pump flow rates, the static inverter-converter frequency, the LH_2 and LOX chilldown inverter frequencies, the LOX and LH_2 flowmeter, and the LOX and LH_2 pump speeds. A 400 Hz GSE calibration frequency was used for the pump flow rates and the static inverter-converter and chilldown inverter frequencies, a 100 Hz GSE calibration frequency was used for the flowmeters, and a 1500 Hz calibration frequency was used for the pump speeds. The telemetry system forward and reflected RF powers were then measured, and the telemetry system open loop VSWR was determined. The LOX and LH_2 chilldown pumps were turned on, and the chilldown inverter frequencies and phase voltages were measured by hardwire and telemetry.

A series of measurements were then made of the common bulkhead pressure, the LH_2 ullage pressure, and their 20 and 80 per cent calibration voltages, the LOX ullage pressure, and the LH_2 and LOX emergency detection system pressures.

4.3.25 (Continued)

After the 20 and 80 per cent calibration tests, the common bulkhead pressure and the ambient LH_2 ullage pressure were remeasured. Common bulkhead pressures reflected the vacuum drawn on the bulkhead. The rate gyro was then turned on, and the RACS and telemetry calibrations were performed.

The final prelaunch checks were then started. During the umbilicals-in test, the battery simulators were turned on, and measurements were made of the battery simulator voltages and the electrical support equipment load bank voltages. During the umbilicals-out test, the checkout batteries were turned on and the checkout battery voltages were measured. The transducers for the common bulkhead pressure and the LH_2 and LOX ullage pressures were all turned off, and the transducer output voltages were measured. The LH_2 and LOX fast-fill sensor simulated wet conditions were then turned off.

The forward and aft power buses were transferred to internal, and the bus voltages were measured. Both range safety receivers were transferred to internal power, and their low level signal strength indications were measured.

The EBW ullage rocket firing unit disable command was turned off, the range safety system safe and arm device was set to the ARM condition, the DDAS antenna input was turned on, and the propellant dispersion cutoff command inhibit was turned off for both range safety receivers. It was verified that the open loop PCM RF signal was being received at the PCM and DDAS ground stations. The cold helium supply shutoff valve was opened. For the umbilicals-out test only, the external power was turned off for the talkback bus, the forward and aft power buses, and the range safety receivers and EBW firing

4.3.25 (Continued)

units; the aft and forward umbilicals were ejected and visually verified to be disconnected; then, the local sense indications were verified to be on. For the umbilicals-in test only, the external powers were on; it was verified that the umbilicals remained connected; and the local sense indications were verified to be off. The emergency detection system ullage pressures were then measured for both tests. The prelaunch checks were completed with simulated liftoff.

Following the simulated liftoff, a telemetry calibration was accomplished, and the preseparation checks were conducted. The two ullage rocket ignition EBW firing units were charged. The LH_2 and LOX prevalves were cycled, and the LH_2 chilldown pump was turned off. The fire ullage ignition command was turned on, and it was verified that the two ullage ignition EBW firing units responded properly and that the ullage ignition pulse sensors were on. The aft separate simulation 1 and 2 signals were then turned on to simulate stage separation. During the above part of the umbilicals-in test only, additional checks verified that the ullage rocket firing unit disable command prevented the ignition EBW firing units from charging, and discharged the previously charged firing units while preventing them from firing.

APS roll and engine start checks were conducted following the simulated stage separation. The instrument unit (IU) substitute -28 volt power was turned on and the voltage was measured. For the APS roll checks, attitude control nozzles I-IV and III-II were turned on and off; and the corresponding APS engine valves

4.3.25 (Continued)

were measured for open and closed indication voltages. In addition, the APS engine thrust chamber pressures were measured with the engine valves in the open and closed positions, the thrust chamber throat plugs installed, and pressure upstream of the valves. This procedure was then repeated for attitude control nozzles I-II and III-IV and their corresponding APS engines, to satisfactorily complete the roll checks.

The LOX chilldown pump was then turned off, and the LH_2 and LOX chilldown shutoff valves were cycled open and closed. With the simulated ignition detected indication and the simulated mainstage OK indication turned on to simulate a satisfactory engine start, the engine start sequence was accomplished. The two ullage rocket jettison EBW firing units were charged, the fire ullage jettison command was turned on, and it was verified that both ullage jettison firing units responded properly and that the ullage jettison pulse sensors were on. During this part of the umbilicals-in test only, additional checks verified that the ullage rocket firing unit disable command prevented the jettison EBW firing units from charging, and discharged the previously charged firing units while preventing them from firing.

Following the engine start sequence, the hydraulic gimbal and propellant utilization valve slew checks were conducted, starting with the step response gimbal and LOX valve slew checks. The propellant utilization system ratio valve position and the hydraulic system pressure were both measured, and the LOX bridge 1/3 checkout relay was turned on. A series of step response gimbal checks were conducted at 0 to -3 degrees, -3 to 0 degrees, 0 to +3 degrees, and +3 to 0 degrees, in the pitch and yaw planes. As the results of these checks

4.3.25 (Continued)

were compatible with the results of the same checks during the hydraulic system automatic checkout, H&CO 1B55824 (reference paragraph 4.3.21), the measured data was not repeated. Following the gimbal sequence, the propellant utilization system ratio valve position was again measured, and the LOX bridge 1/3 checkout relay was turned off. The 0.6 Hz gimbal and LH_2 propellant utilization valve slew checks were conducted next. The propellant utilization system ratio valve position and the hydraulic pressure were measured, and the LH_2 bridge 1/3 checkout relay was turned on. A 0.5 degree gimbal signal, at 0.6 Hz, was applied in the pitch and yaw planes. The engine position command currents and resulting instrument unit actuator piston positions were found to be within the required limits throughout the cycling in both planes, for the umbilicals-in and umbilicals-out tests. At the completion of the gimbal sequences, the hydraulic actuator piston positions and the instrument unit engine pitch and yaw positions were measured, and the hydraulic system functions were measured with the hydraulic system pressurized. The propellant utilization system ratio valve position was measured, and the LH_2 bridge 1/3 checkout relay was turned off.

The first burn and coast period sequences were conducted next. During the first burn pressurization, the helium pressures of the LOX and LH_2 pressurization control modules were measured while the helium supply valves were temporarily open, and again after the pressure switch supplies were closed and the flight control pressure switches were verified to be off. The engine cutoff was then accomplished, the auxiliary hydraulic pump was set for coast mode operation, the LH_2 first burn relay was turned off, and the LH_2 pressurization

4.3.25 (Continued)

control module helium pressure was again measured. The LOX chilldown pump purge was started, and the LOX pump motor container helium pressure was measured. The coast period command was turned on, the LOX flight pressurization system was turned off, and the engine pump purge was started. The simulated mainstage OK indication was turned off to complete the first burn sequence.

The engine restart preparations were conducted next. The 70 pound ullage engine command 1 was turned on and off, the LH_2 continuous vent valves were opened, and the ullage engine command 2 was turned on and off. The engine pump purge was completed. The LH_2 boiloff bias signal voltage was measured, then remeasured with the propellant utilization boiloff bias cutoff turned on. The LH_2 continuous vent valves were then closed, and the pressures of the LOX repressurization spheres and cold helium spheres were measured.

The O_2H_2 burner spark excitation systems were verified to operate properly. The proper operation of the LOX and LH_2 repressurization control valves was verified, and the LOX and LH_2 tank cryogenic repressurization sequences were accomplished. The pressures of the cold helium sphere and the LOX repressurization spheres were measured, and the LOX tank ambient repressurization sequence was accomplished. The LOX and LH_2 chilldown pumps were turned on, and the chilldown inverter voltages were measured. The LH_2 tank ambient repressurization sequence was then accomplished. With the propellant utilization valve hardover position command on, the ratio valve position was verified to be less than -20 degrees. The LH_2 and LOX chilldown pumps were turned off, and the and the inverter operating frequencies and voltages were measured. The cold helium supply shutoff valve was then opened, completing the restart preparations.

4.3.25 (Continued)

The engine restart sequence was accomplished with the simulated ignition detected indication and the simulated mainstage OK indication turned on to simulate a satisfactory engine restart. The cold helium supply shutoff valve was closed to complete the restart sequence. The LH_2 second burn repressurization sequence was accomplished, with the LH_2 pressurization control module helium pressure measured with the prepressurization supply open, and again after the pressure switch supply was closed. The engine cutoff was then accomplished, the simulated ignition detected indication was turned off, and the coast period command was turned on.

A series of checks verified that a dry condition of any one LOX or LH_2 point level sensor would not cause engine cutoff, but that a dry condition of any two LOX sensors or any two LH_2 sensors would cause engine cutoff. The sensors were checked by turning off the simulated wet conditions for the combinations of LOX and LH_2 sensors. During the umbilicals-in test only, the operating time of the LOX depletion engine cutoff timer was measured for each combination of LOX sensors.

The emergency detection system and range safety system tests were accomplished next. Verification was made that each of the emergency detection system 1 and 2 engine cutoff commands properly caused engine cutoff. A series of checks then verified that the range safety EBW firing unit arm and engine cutoff command properly charged the range safety firing units and caused engine cutoff, and that the range safety propellant dispersion command properly fired the range safety EBW firing units. During the umbilicals-in test only, additional

4.3.25 (Continued)

checks verified that the range safety 1 and 2 receiver propellant dispersion cutoff command inhibits properly prevented engine cutoff and EBW firing unit operation. As a final range safety system test, it was verified that the range safety system off command properly turned off both range safety receivers.

A series of APS yaw and pitch attitude control checks were conducted next. The yaw attitude control nozzles I-IV and III-IV, plus pitch control nozzle I-P, were turned on and off, and the corresponding APS engine valves were measured for open and closed indication voltages. In addition, the APS engine thrust chamber pressures were measured with the valves open and closed, pressure upstream of the valves, and the thrust chamber throat plugs installed. This procedure was then repeated for yaw attitude control nozzles I-II and III-II and pitch control nozzle III-P, satisfactorily completing the yaw and pitch checks. After a final telemetry calibration, the stage shutdown was accomplished, completing the all systems test.

During the first attempt of issue two, FARR 500-225-271 reported that the PCM RF transmitter, P/N 1B52721-521, S/N 034, was erratic in operation. The discrepant transmitter was removed and replaced with S/N 011. The second attempt was successful.

One hundred and thirteen revisions were made to the two issues of the procedure as follows:

a. Twenty-four revisions were required to update the procedure to the latest configuration.

b. Twenty revisions were corrections of program and procedure errors.

4.3.25 (Continued)

c. Ten revisions were modifications and additions required as supplemental setup instructions.

d. Six revisions authorized special "RF off" tests of the LH_2 not overfill sensor and the LH_2 ullage pressure systems to verify that these systems would function properly under no RF conditions.

e. Five revisions increased program delay times due to the addition of transient suppression diodes.

f. Two revisions authorized the momentary manual reduction of the forward bus 2, 28 vdc voltage to 26.3 vdc to avoid possible damage to the propellant utilization electronics assembly from the high power turn-on voltage spikes.

g. Two revisions authorized the use of the aft 1 secondary battery in place of the battery simulator power in order to maintain the aft bus 1 voltage below 30.5 vdc during engine sequence.

h. Two revisions outlined the procedure necessary to checkout the stage purge system.

i. Two revisions provided for measuring and recording the PU over stability monitor voltage per a NASA request.

j. Two revisions modified the program for a 30-second delay to allow the LH_2 tank flight control to operate within the allotted time. The original delay time of 20 seconds was not adequate.

k. Two revisions authorized turning off the RF group transfer ground station monitor to verify that the Data Laboratory was receiving the stage RF signal.

l. Two revisions attributed the out-of-tolerance condition of the component test power to a 2 volt drop in the ground return system.

m. Two revisions stated that the out-of-tolerance condition of the LH_2 ullage pressure was due to the transducer being RF sensitive. A retest of the system was acceptable.

n. Two revisions attributed the malfunction of the cold helium sphere pressure to the RFI susceptibility of the transducer.

o. Two revisions attributed the malfunction of the LH_2 tank overfill sensor to the RFI susceptibility of the sensor.

4.3.25 (Continued)

p. Two revisions provided for measuring and recording the auxiliary hydraulic pump motor gas pressure and pump air tank pressure before and after gimbaling.

q. Two revisions authorized a special test to isolate the source of an undesired positive pulse that appeared on the switch selector output monitor voltage when engine cutoff was turned on.

r. Two revisions gave instructions for measuring the threshold voltage level of the LH_2 fastfill sensor wet condition after the sensor cycled during the engine sequence section.

s. Two revisions explained that a channel 6 lockout was due to the response conditioner not sending a "transfer enable" signal. The conditioner was reset and testing continued.

t. Two revisions authorized the rerunning of the umbilicals-in section of the procedure as the PCM transmitter open loop operation appeared to be abnormal. Investigation revealed that the condition was due to test stand environmental conditions and not the RF system.

u. One revision attributed the out-of-tolerance malfunction of the T/M antenna forward power exceeding the procedure tolerance of 19.00 $\pm$7.52 watts to test stand environmental conditions.

v. One revision verified that the PCM RF power output was greater than 14 watts per a NASA request.

w. One revision deleted a portion of the test that was previously accomplished.

x. One revision rechecked the LOX tank nonpropulsive vent valve and latch system prior to the umbilicals-out test. The first check was not correctly accomplished due to an operator error.

y. One revision attributed the malfunction of the LH_2 ullage pressure sensor to the RFI susceptibility of the transducer.

z. Two revisions authorized the performance of the stage power setup procedure with the same on-line changes incorporated in the accepted issue of stage power setup, 1B55813 G.

4.3.25 (Continued)

aa. One revision attributed the SIM channels 18 and 38 interrupt to the component test bus being turned off. The executive was reloaded and testing resumed.

ab. One revision established a delay after sending the LH_2 and LOX chilldown differential pressure on command before measuring the chilldown pump differential pressures. In the original program, the computer measured the pressure signal before the energizing relay on the stage closed.

ac. One revision attributed the GN_2 supply pressure too low malfunction to a low trailer pressure. The pressure of 1800 psig was acceptable.

ad. One revision attributed the computer line printer lockup to an unknown cause, which is under investigation.

ae. One revision attributed the LH_2 chilldown pump differential pressure out-of-tolerance malfunction to extraneous noise. A review of the data indicated proper operation within specifications and tolerances.

af. One revision attributed the aft bus 1 out-of-tolerance malfunction to a surface charge not being drained off the battery prior to the test.

ag. One revision temporarily secured the hydraulic pump during the PCM transmitter checks.

ah. One revision authorized a special test to verify proper operation of the LH_2 fastfill sensor when the PU hardover command was removed.

ai. One revision authorized a special test to determine system response to the LH_2 and LOX chilldown differential pressure TM to umbilical switch over command and system noise on the LH_2 chilldown differential pressure transducer, with the PCM RF transmitter on and off.

aj. One revision attributed the cycling of the LH_2 fastfill sensor to RFI susceptibility.

ak. One revision authorized the deletion of one step of a previous revision.

4.3.25.1 Test Data Table, All Systems Test

Function	Umbil.-In	Umbil.-Out	Limits
Power Setup			
PU Inv and Elect. Current (amps)	4.00	3.801	5.0 max
Aft Bus 1 Current with Eng Cont Bus Pwr On (amps)	2.00	1.70	2.7 ± 3.0
Aft Bus 1 Voltage with Eng Cont Bus Pwr On (X) (vdc)	28.04	28.04	28.0 ± 2.0
Engine Control Bus Voltage (vdc)	27.94	27.97	Meas.(X) ± 1.0
Component Test Pwr Voltage (vdc)	27.56	27.64	Meas.(X) ± 1.0
Aft Bus 1 Current with Eng Ing Bus Pwr On (amps)	2.10	2.00	2.7 ± 3.0
Aft Bus 1 Voltage with Eng Ing Bus Pwr On (Y) (vdc)	28.00	28.04	28.0 ± 2.0
Engine Ingition Bus Voltage (vdc)	27.97	28.03	Meas.(Y) ± 1.0
Aft Bus 1 Current with APS Bus Pwr On (amps)	1.90	1.50	2.7 ± 3.0
Aft Bus 2 Current (amps)	0.00	0.00	5.0 max
Aft Bus 2 Voltage (vdc)	56.16	56.00	56.0 ± 4.0
Propulsion System Setup			
Amb He Pneu Sphere Press. D236 (psia)	689.9	701.1	700.0 ± 50.0
Cold Helium Sphere Press. D016 (psia)	762.8 †	690.2 †	900.0 ± 50.0
Eng Cont He Supply Press. D019 (psia)	1542.7	1542.7	1450.0 min
Cont He Reg Discharge Press. D014 (psia)	533.3	530.5	515.0 ± 50.0
LH_2 Repress. He Sphere Press. D020 (psia)	435.6	394.5	*
LOX Repress. He Sphere Press. D088 (psia)	689.9	660.0	*
APS 1 Fuel Sup Manf Press (psia)	30.55	28.80	38 ± 15
APS 1 Oxid Sup Manf Press (psia)	34.04	32.73	38 ± 15
APS 2 Fuel Sup Manf Press (psia)	31.86	28.80	38 ± 15
APS 2 Oxid Sup Manf Press (psia)	30.99	29.68	38 ± 15
APS 1 Fuel Ull Vol Press (psia)	49.3	49.3	50 ± 15
APS 1 Oxid Ull Vol Press (psia)	44.1	43.6	50 ± 15
APS 2 Fuel Ull Vol Press (psia)	48.4	48.0	50 ± 15
APS 2 Oxid Ull Vol Press (psia)	43.6	43.2	50 ± 15
LH_2 Prepressurization Sequence			
LH_2 Press. Control Module GH_2 Press. D104 (psia)	236.49	236.49	50.0 min

†See revision n
*Limits not specified

4.3.25.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
EBW and Telemetry Checks			
PCM/FM Transmitter Output with PCM RF Assy Off (watts)	-0.15	**	2.0 max
PCM/FM Transmitter Output with PCM RF Assy On (watts)	17.70	**	10.0 min
T/M Antenna 1 Forward Power (watts)	17.7[illegible]7	17.667	21.75 ± 6.75
T/M RF System Reflected Power (watts)	0.529	0.542	3.08 max
Telemetry System Closed Loop VSWR	1.417	1.424	2.0 max
Inv-Conv 115 vac Output (vac)	114.60	114.46	115 ± 3.45
Inv-Conv 5 vdc Output (vdc)	5.02	5.00	4.9 ± 0.2
Inv-Conv 21 vdc Output (vdc)	21.41	21.35	21.25 ± 1.25
Inv-Conv Operating Frequency (Hz)	401.48	401.17	400.0 ± 6.0
Hydraulic System Checks			
Reservoir GN_2 Mass (lbs)	1.898	1.917	1.925 ± 0.2
Corrected Reservoir Oil Level (%)	99.6	99.5	95.0 min
Hydraulic System Unpressurized			
Hydraulic System Pressure (psia)	1375.563	1372.313	*
Accumulator GN_2 Pressure (psia)	2269.188	2375.563	*
Accumulator GN_2 Temperature (°F)	56.891	76.057	*
Reservoir Oil Temperature (°F)	57.672	77.232	*
Reservoir Oil Level (%)	87.850	90.227	*
Reservoir Oil Pressure (psia)	81.611	83.357	*
Pump Inlet Oil Temperature (°F)	59.630	76.453	*
T/M Yaw Actuator Position (deg)	1.003	0.987	*
Corrected T/M Yaw Act. Pos (deg)	1.011	0.995	*
IU Yaw Actuator Position (deg)	1.019	0.989	*
Corrected IU Yaw Act. Pos (deg)	1.026	0.989	*
T/M Pitch Actuator Position (deg)	-0.082	-0.020	*
Corrected T/M Pitch Act. Pos (deg)	-0.089	-0.026	*
IU Pitch Actuator Position (deg)	-0.044	-0.015	*
Corrected IU Pitch Act. Pos (deg)	-0.051	0.989	*
IU Substitute 5V Power Supply (vdc)	4.994	4.999	*
Aft 5v Excitation Module (vdc)	4.995	4.995	*
Aft Bus 2 Current (amps)	-0.600	-1.199	*
Hydraulic System Pressurized			
Hyd System 4 Second Press. Change (psia)	265.1	268.4	200.0 min
Hydraulic System Pressure (psia)	3611.188	3611.188	*

*Limits not specified
**Measurements not applicable

4.3.25.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Accumulator GN_2 Pressure (psia)	3594.813	3600.250	*
Accumulator GN_2 Temperature (^oF)	81.936	98.820	*
Reservoir Oil Temperature (^oF)	57.672	77.625	*
Reservoir Oil Level (%)	33.170	39.801	*
Reservoir Oil Pressure (psia)	172.391	173.699	*
Pump Inlet Oil Temperature (^oF)	58.458	78.412	*
T/M Yaw Actuator Position (deg)	-0.013	-0.028	*
Corrected T/M Yaw Act. Pos (deg)	-0.013	-0.028	*
IU Yaw Actuator Position (deg)	0.014	0.029	*
Corrected IU Yaw Act. Pos (deg)	0.014	0.029	*
T/M Pitch Actuator Position (deg)	-0.066	-0.066	*
Corrected T/M Pitch Act. Pos (deg)	-0.066	-0.066	*
IU Pitch Actuator Position (deg)	-0.044	-0.044	*
Corrected IU Pitch Act. Pos (deg)	-0.044	-0.044	*
IU Substitute 5v Power Supply (vdc)	4.999	4.999	*
Aft 5v Excitation Module (vdc)	4.996	4.996	*
Aft Bus 2 Current (amps)	41.60	44.880	*
FRATS Calibration			
LOX Circ Pump Flowrate Ind (vdc)	3.871	3.876	3.866 ± 0.100
LH_2 Circ Pump Flowrate Ind (vdc)	3.871	3.882	3.866 ± 0.100
Static Inv-Conv Freq Ind (vdc)	2.682	2.702**	2.600 ± 0.100
LH_2 C/D Inv Freq Ind (vdc)	2.620	2.641	2.600 ± 0.100
LOX C/D Inv Freq Ind (vdc)	2.650	2.630	2.600 ± 0.100
LOX Flowmeter Indication (vdc)	1.691	1.712	1.667 ± 0.100
LH_2 Flowmeter Indication (vdc)	1.697	1.697	1.667 ± 0.100
LOX Pump Speed Indication (vdc)	3.189	3.199	3.125 ± 0.100
LH_2 Pump Speed Indication (vdc)	1.276	1.287	1.250 ± 0.100
Telemetry RF Checks			
T/M Antenna 1 Forward Power (watts)	19.867	19.748	21.75 ± 6.75
T/M RF System Reflected Power (watts)	1.917	0.643	3.08 max
Telemetry System Open Loop VSWR	1.900	1.439	3.0 max
Chilldown Inverter Telemetry Checks			
LH_2 C/D Inv Frequency (Hz)	400.6	399.3	400.0 ± 4.0
LH_2 C/D Inv Phase AB Volt. (vac)	54.7	52.9	*
LH_2 C/D Inv Phase AC Volt. (vac)	54.9	52.9	*
LOX C/D Inv Frequency (Hz)	399.9	399.9	400.0 ± 4.0
LOX C/D Inv Phase AB Volt. (vac)	54.6	52.9	*
LOX C/D Inv Phase AC Volt. (vac)	54.7	53.1	*

* Limits not specified

**Engineering states this value is good and the computer will not malfunction for the Z millivolt apparent out-of-tolerance.

4.3.25.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Pressure Measurements			
Common Bulkhead Internal Press. (psia)	0.947	0.893	0.784 ± 0.5
Common Bulkhead 20% Calib (vdc)	1.055	1.060	1.0 ± 0.1
Common Bulkhead Press. (psia)	1.116	1.037	0.784 ± 0.5
Common Bulkhead 80% Calib (vdc)	4.015	4.015	4.0 ± 0.1
Common Bulkhead Press. (psia)	0.931	0.983	0.784 ± 0.5
LH_2 Ullage Pressure (psia)	16.055 †	15.896 †	14.7 ± 1.0
LH_2 Ullage 20% Calib (vdc)	1.100	1.130 †	1.0 ± 0.1
LH_2 Ullage Amb Press. (psia)	16.055 †	16.055 †	14.7 ± 1.0
LH_2 Ullage 80% Calib (vdc)	4.164 †	4.185 †	4.0 ± 0.1
LH_2 Ullage Amb Press. (psia)	16.055 †	16.107 †	14.7 ± 1.0
LOX Ullage Pressure (psia)	14.581	14.634	14.7 ± 1.0
LH_2 EDS Transducer 1 Press. (psia)	14.2	14.5	14.7 ± 1.0
LH_2 EDS Transducer 2 Press. (psia)	14.1	14.0	14.7 ± 1.0
LOX EDS Transducer 1 Press. (psia)	14.9	14.5	14.7 ± 1.0
LOX EDS Transducer 2 Press. (psia)	14.3	14.2	14.7 ± 1.0
Final Prelaunch Checks			
Fwd Bus 1 Batt. Sim. (Bus 4D30) (vdc)	28.16	**	28.0 ± 2.0
Fwd Bus 2 Batt. Sim. (Bus 4D20) (vdc)	28.64	**	28.0 ± 2.0
Aft Bus 1 Batt. Sim. (Bus 4D10) (vdc)	30.08	**	29.5 ± 1.5
Aft Bus 2 Batt. Sim. (Bus 4D40) (vdc)	55.60	**	56.0 ± 4.0
Bus 4D20 ESE Load Bank (vdc)	0.00	**	0.0 ± 1.0
Bus 4D40 ESE Load Bank (vdc)	-0.16	**	0.0 ± 1.0
Bus 4D30 ESE Load Bank (vdc)	0.00	**	0.0 ± 1.0
Bus 4D10 ESE Load Bank (vdc)	0.08	**	0.0 ± 1.0
Fwd Bus 1 C/O Batt. (Bus 4D30) (vdc)	**	30.00	29.5 ± 1.5
Fwd Bus 2 C/O Batt. (Bus 4D20) (vdc)	**	30.20	29.5 ± 1.5
Aft Bus 1 C/O Batt. (Bus 4D10) (vdc)	**	29.92	29.5 ± 1.5
Aft Bus 2 C/O Batt. (Bus 4D40) (vdc)	**	60.24	60.5 ± 1.5
Common Bulkhead Press. Xducer (vdc)	0.000	0.000	0.0 ± 0.353
LH_2 Ullage Press. Xducer (vdc)	0.000	0.000	0.0 ± 0.353
LOX Ullage Press. Xducer (vdc)	0.015	0.124	0.0 ± 0.353
Fwd Bus 1 Internal (Bus 4D31) (vdc)	28.08	29.44	28.0 ± 2.0
Fwd Bus 2 Internal (Bus 4D21) (vdc)	27.76	28.60	28.0 ± 2.0
Aft Bus 1 Internal (Bus 4D11) (vdc)	29.72	29.72	28.0 ± 2.0
Aft Bus 2 Internal (Bus 4D41) (vdc)	54.64	54.64	56.0 ± 4.0
Receiver 1 Low Level Signal (vdc)	3.57	3.55	2.5 min
Receiver 2 Low Level Signal (vdc)	3.78	3.77	2.5 min
LH_2 EDS 1 Ullage Pressure (psia)	14.40	14.40	14.7 ± 1.0
LH_2 EDS 2 Ullage Pressure (psia)	14.00	14.06	14.7 ± 1.0
LOX EDS 1 Ullage Pressure (psia)	14.58	14.64	14.7 ± 1.0
LOX EDS 2 Ullage Pressure (psia)	14.30	14.30	14.7 ± 1.0

**Measurements not applicable

†See revision m

4.3.25.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
APS Roll Checks			
IU Substitute -28 Volt Power (vdc)	-27.999	-27.919	-28.5 ± 2.5
Attitude Control Nozzles I-IV and III-II On			
APS Engine 1-1 Valves Open Ind (vdc)	4.16	3.99	3.9 ± 0.4
APS Engine 2-1 Valves Open Ind (vdc)	4.09	3.92	3.9 ± 0.4
APS Engine 1-1 Chamber Pressure with Valves Open (psia)	26.69	24.36	*
APS Engine 2-1 Chamber Pressure with Valves Open (psia)	25.12	24.06	*
Attitude Control Nozzles I-IV and III-II Off			
APS Engine 1-1 Valves Open Ind (vdc)	0.00	0.00	0.00 ± 0.25
APS Engine 2-1 Valves Open Ind (vdc)	0.00	-0.00	0.00 ± 0.25
APS Engine 1-1 Chamber Pressure with Valves Closed (psia)	15.90	14.63	*
APS Engine 2-1 Chamber Pressure with Valves Closed (psia)	14.78	14.78	*
Attitude Control Nozzles I-II and III-IV On			
APS Engine 1-3 Valves Open Ind (vdc)	4.09	3.93	3.9 ± 0.4
APS Engine 2-3 Valves Open Ind (vdc)	4.04	3.89	3.9 ± 0.4
APS Engine 1-3 Chamber Pressure with Valves Open (psia)	26.65	23.05	*
APS Engine 2-3 Chamber Pressure with Valves Open (psia)	26.30	23.54	*
Attitude Control Nozzles I-II and III-IV Off			
APS Engine 1-3 Valves Open Ind (vdc)	0.00	0.00	0.00 ± 0.25
APS Engine 2-3 Valves Open Ind (vdc)	0.00	-0.00	0.00 ± 0.25

* Limits not specified

4.3.25.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
APS Engine 1-3 Chamber Pressure with Valves Closed (psia)	15.21	14.78	*
APS Engine 2-3 Chamber Pressure with Valves Closed (psia)	15.06	14.42	*
Hydraulic Gimbal Step Response Check			
Ratio Valve Pos. (Relay Off)(P)(deg)	-0.13	0.01	0.0 ± 1.5
Hydraulic System Pressure (psia)	3611.0	3631.0	3575 ± 75
Ratio Valve Pos. (Relay On) (deg)	33.28	33.21	20.0 min
Ratio Valve Pos (Relay Off) (deg)	1.63	1.51	Meas.(P) ± 1.5
Hydraulic System Pressure (psia)	3624.0	3618.0	3575 ± 75
Pitch Act. Piston Pos., AO (deg)	-0.051	-0.051	0.0 ± 0.517
Pitch Act. Piston Pos., BO (deg)	-0.051	-0.020	0.0 ± 0.517
Yaw Act. Piston Position, AO (deg)	-0.013	0.002	0.0 ± 0.517
Yaw Act. Piston Position, BO (deg)	-0.013	-0.013	0.0 ± 0.517
Engine Pitch Position, IU (deg)	-0.044	-0.029	0.0 ± 0.517
Engine Yaw Position, IU (deg)	0.014	0.014	0.0 ± 0.517
Hydraulic System Pressurized			
Hydraulic System Pressure (psia)	3621.0	3621.0	*
Accumulator GN_2 Pressure (psia)	3622.125	3622.125	*
Accumulator GN_2 Temperature (°F)	66.660	84.680	*
Reservoir Oil Temperature (°F)	89.389	125.227	*
Reservoir Oil Level (%)	33.295	41.428	*
Reservoir Oil Pressure (psia)	177.188	178.063	*
Pump Inlet Oil Temperature (°F)	105.510	135.500	*
T/M Yaw Actuator Position (deg)	-0.013	0.002	*
Corrected T/M Yaw Act. Pos. (deg)	-0.013	0.009	*
IU Yaw Actuator Position (deg)	0.014	0.044	*
Corrected IU Yaw Act. Pos. (deg)	0.006	0.044	*
T/M Pitch Actuator Position (deg)	-0.066	-0.051	*
Corrected T/M Pitch Act. Pos. (deg)	-0.066	-0.058	*
IU Pitch Actuator Position (deg)	-0.044	-0.015	*
Corrected IU Pitch Act. Pos. (deg)	-0.036	-0.015	*
IU Substitute 5v Power Supply (vdc)	5.005	4.999	*
Aft 5v Excitation Module (vdc)	4.997	4.994	*
Aft Bus 2 Current (amp)	44.60	**	*
Aft Checkout Battery 2 Current (amp)	**	45.00	*
Ratio Valve Pos. (Relay On) (deg)	-27.328	-27.328	-20.0 max

*Limits not specified
**Measurements not applicable

4.3.25.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
First Burn and Coast Period			
LOX Press. Module Helium Pressure D105			
Cold Helium Supply Open (psia)	140.609	155.344	*
LOX Press. Sw. Supply Closed (psia)	129.156	144.434	*
LH_2 Press. Module Helium Pressure D104			
LH_2 Prepress. Supply Open (psia)	412.156	406.695	*
LH_2 Press. Sw. Supply Closed (psia)	307.41	304.13	*
LH_2 First Burn Relay Off (psia)	240.85	236.49	*
Engine Restart Preparations			
LH_2 Boiloff Bias Signal M010:			
Bias Cutoff Off (vdc)	0.51	0.48	0.0 ± 2.5
Bias Cutoff On (vdc)	7.953	8.630	4.0 min
LOX Repress. Spheres, D088 (psia)	671.19	663.72	*
Cold Helium Spheres, D016 (psia)	457.30	415.56	*
Cold Helium Spheres, D016 (psia)	323.63	392.38	*
LOX Repress. Spheres, D088 (psia)	667.45	656.28	*
Chilldown Pumps On			
LOX C/D Inv Phase AB Volt. (vac)	56.7	58.7	50.0 min
LOX C/D Inv Phase AC Volt. (vac)	56.3	58.4	50.0 min
LOX C/D Inv Phase A1B1 Volt. (vac)	56.4	58.7	50.0 min
LOX C/D Inv Phase A1C1 Volt. (vac)	56.2	58.9	50.0 min
LH_2 C/D Inv Phase AB Volt. (vac)	55.8	57.0	50.0 min
LH_2 C/D Inv Phase AC Volt. (vac)	55.3	56.4	50.0 min
LH_2 C/D Inv Phase A1B1 Volt. (bac)	55.8	57.1	50.0 min
LH_2 C/D Inv Phase A1C1 Volt. (vac)	55.1	56.3	50.0 min
Chilldown Pumps Off			
LH_2 C/D Inv Frequency (Hz)	389.5	389.5	390.0 ± 1.0
LH_2 C/D Inv Phase AB Volt. (vac)	0.00	0.00	0.0 ± 1.5
LH_2 C/D Inv Phase AC Volt. (vac)	0.00	0.00	0.0 ± 1.5
LOX C/D Inv Frequency (Hz)	389.5	389.5	390.0 ± 1.0
LOX C/D Inv Phase AB Volt. (vac)	0.07	0.00	0.0 ± 1.5
LOX C/D Inv Phase AC Volt. (vac)	0.00	0.00	0.0 ± 1.5

*Limits not specified

4.3.25.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
LH_2 Second Burn Repressurization			
LH_2 Press. Module Helium Pressure D104			
LH_2 Prepress. Supply Open (psia)	416.516	405.609	*
LH_2 Press. Sw. Supply Closed (psia)	298.680	292.133	*
LH_2 Second Burn Off	245.223	238.672	*
LOX Depletion Timer Check			
LOX Sensors 1 and 2 Dry (sec)	0.565	**	0.560 ± 0.025
LOX Sensors 1 and 3 Dry (sec)	0.570	**	0.560 ± 0.025
LOX Sensors 2 and 3 Dry (sec)	0.568	**	0.560 ± 0.025
APS Yaw Checks			
Attitude Control Nozzles I-IV and III-IV On			
APS Engine 1-1 Valves Open Ind (vdc)	4.06	3.94	3.9 ± 0.4
APS Engine 2-3 Valves Open Ind (vdc)	3.97	3.85	3.9 ± 0.4
APS Engine 1-1 Chamber Pressure with Valves Open (psia)	23.94	23.09	*
APS Engine 2-3 Chamber Pressure with Valves Open (psia)	23.53	23.12	*
Attitude Control Nozzles I-IV and III-IV Off			
APS Engine 1-1 Valves Open Ind (vdc)	0.00	0.00	0.0 ± 0.25
APS Engine 2-3 Valves Open Ind (vdc)	0.00	0.00	0.0 ± 0.25
APS Engine 1-1 Chamber Pressure with Valves Closed (psia)	15.05	14.63	*
APS Engine 2-3 Chamber Pressure with Valves Closed (psia)	15.06	14.63	*
Attitude Control Nozzles I-II and III-II On			
APS Engine 1-3 Valves Open Ind (vdc)	4.01	3.90	3.9 ± 0.4
APS Engine 2-1 Valves Open Ind (vdc)	4.01	3.88	3.9 ± 0.4
APS Engine 1-3 Chamber Pressure with Valves Open (psia)	23.89	22.20	*
APS Engine 2-1 Chamber Pressure with Valves Open (psia)	23.43	22.80	*

*Limits not specified
**Measurement not applicable

4.3.25.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Attitude Control Nozzles I-II and III-II Off			
APS Engine 1-3 Valves Open Ind (vdc)	0.00	0.00	0.0 ± 0.25
APS Engine 2-1 Valves Open Ind (vdc)	0.00	-0.00	0.0 ± 0.25
APS Engine 1-3 Chamber Pressure with Valves Closed (psia)	14.99	14.99	*
APS Engine 2-1 Chamber Pressure with Valves Closed (psia)	14.78	14.35	*
Attitude Control Nozzle I-P On			
APS Engine 1-2 Valves Open Ind (vdc)	4.16	4.03	3.9 ± 0.4
APS Engine 1-2 Chamber Pressure with Valves Open (psia)	26.70	24.58	*
Attitude Control Nozzle I-P Off			
APS Engine 1-2 Valves Open Ind (vdc)	0.00	0.00	0.0 ± 0.25
APS Engine 1-2 Chamber Pressure with Valves Closed (psia)	15.68	14.62	*
Attitude Control Nozzle III-P On			
APS Engine 2-2 Valves Open Ind (vdc)	4.07	3.92	3.9 ± 0.4
APS Engine 2-2 Chamber Pressure with Valves Open (psia)	26.04	24.13	*
Attitude Control Nozzle III-P Off			
APS Engine 2-2 Valves Open Ind (vdc)	0.00	-0.00	0.0 ± 0.25
APS Engine 2-2 Chamber Pressure with Valves Closed (psia)	15.87	14.81	*

*Limits not specified

4.3.26 Hydraulic System Poststorage Operating and Securing (1B41006 A)

The purpose of this procedure was to obtain poststorage closed loop hydraulic fluid samples and to secure the hydraulic system prior to removal of the stage from the test stand for transfer to the VCL.

Checkout was initiated on 6 June 1968, and satisfactorily completed on 21 June 1968. Components of the stage hydraulic system installed during this checkout included the main engine driven hydraulic pump, P/N 1A66240-503, S/N X457808; the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454588; the hydraulic pitch and yaw actuator assemblies, P/N 1A66248-505, S/N's 51 and 53; and the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00034.

Prior to the start of the checkout, the GSE hydraulic pumping unit (HPU), P/N 1A67443-1, was flushed and checked for hydraulic fluid cleanliness, then connected to the stage hydraulic system by pressure and return hoses. The HPU provided high pressure hydraulic fluid to the stage hydraulic system during the checkout.

The accumulator/reservoir was charged with gaseous nitrogen, and the stage auxiliary hydraulic pump air bottle was charged to a pressure of 475 $\pm$50 psig. Verification was made that all components of the stage hydraulic system were securely installed and that each hydraulic connection was tightened to the proper torque value. All bleed valves were verified to be closed, and all external signs of hydraulic fluid were rinsed from the system.

4.3.26 (Continued)

With the midstroke locks installed on the hydraulic actuators, the auxiliary hydraulic pump was turned on and operated for 6 minutes, bringing the system pressure to the required 3600 $\pm$100 psig. After shutting down the auxiliary pump, closed loop system fluid samples were obtained, for cleanliness evaluation, from the hydraulic actuators and the reservoir inlet sampling valve. Particle counts for the various micron ranges were acceptable for all samples.

Following closed loop sampling, the hydraulic system was refilled to replace the sampling fluid loss. During the system refill, the HPU was turned on and operated for 3 minutes with system pressure at 3650 psig; then, the shutdown sequence of the procedure was begun.

The shutdown sequence of this checkout included a final air content test, which provided information necessary for system analysis by discharging a portion of the internal system fluid volume overboard. The volume discharged was determined to be a function of fluid thermal expansion under ground operating conditions (0°F to 160°F). The HPU was turned on, and the system pressure was increased to 3650 $\pm$50 psig, the bypass valve was opened, and the HPU turned off. Verification was made that the return pressure gauge indicated a minimum of 200 psig. The shutoff valve was cycled open and closed until the return pressure was reduced to 180 $\pm$5 psig. An empty 100 ml graduate was placed under the drain port, and by cycling the reservoir drain valve open and closed, the return pressure was decreased to 80 $\pm$5 psig. The 9.5 milliliter volume of fluid bled off was less than the 16 milliliter maximum, as specified per design requirements.

4.3.26 (Continued)

The reservoir oil temperature was measured at 75.7°F, and based on the curve for temperature versus drained fluid volume, a total of 260 milliliters of hydraulic fluid was removed.

The HPU was disconnected from the stage system and secured. Hydraulic system preparations for stage removal from the test stand included depressurization of the GN_2 accumulator, the stage auxiliary hydraulic pump case, and the air supply bottle. All auxiliary equipment was removed from the hydraulic system, and all sample ports were capped. The accumulator/reservoir drain hose was removed, and a plastic dust cover was installed on the port of the reservoir low pressure relief valve. This completed the securing of the system for stage transfer to the VCL.

There were no recorded discrepancies during this checkout, and no FARR's were initiated. Two revisions were recorded in the procedure for the following:

a. One revision modified the slope of the curve depicting temperature versus drained hydraulic fluid volume to provide for greater fluid thermal expansion due to higher ground operating temperatures.

b. One revision provided instructions to obtain additional fluid samples to verify proper cleanliness level of the hydraulic system following the third run of the all systems test, reference paragraph 4.3.25.

4.3.27 Forward Skirt Thermoconditioning System Poststorage Checkout (1B41883 C)

The forward skirt thermoconditioning system was tested in preparation for transfer to the VCL and shipment to FTC at completion of the stage poststorage checkout operations. The procedure utilized the thermoconditioning servicer, P/N 1A78829-1, which had conditioned and supplied the water/methanol heat transfer fluid to the forward skirt thermoconditioning system (TCS), P/N 1B38426-213, during checkout operations.

Checkout included the water/methanol cleanliness test, the specific gravity test, the TCS differential pressure test, the TCS drying procedure, the TCS leak check, and preparation for shipment. The purpose of the cleanliness test was to ensure against contamination of the water/methanol solution by material that could cause TCS failure by restriction of the flow or cause pump abrasion. The specific gravity test checked for proper water/methanol concentration to obtain valid differential pressure measurements during the TCS, "delta P test", which was conducted to check for correct TCS geometry and flow distribution. A drying procedure utilized gaseous nitrogen to purge the TCS of water/methanol vapor. The initial drying procedure prepared the TCS for the leak check, and a final drying of the system was accomplished to preclude the possibility of corrosion in the TCS cold plates prior to and during shipment.

The TCS checkout was initiated on 7 June 1968, and was successfully completed on 26 June 1968. The water/methanol cleanliness test was conducted by circulating water/methanol fluid through the TCS; then, obtaining water/methanol samples. The water/methanol samples were taken to the laboratory for a particle count. The samples were found to be acceptable for each micron range.

4.3.27 (Continued)

Next, the specific gravity and temperature of the water/methanol solution was measured with a hydrometer and thermometer, respectively, to determine that the solution was within the acceptable mixture range for the required delta P testing band. The delta P test was then conducted by measuring the differential pressure between the TCS supply and return lines from the servicer and by measuring the supply and return temperatures with a water/methanol flow rate of 7.8 $\pm$0.2 gpm at a supply pressure of 42.0 +0, -1 psig. The differential pressure was recorded at 14.7 psi with the fluid supply temperature at 66°F and the return temperature at 71°F.

Next, the TCS was purged of water/methanol with GN_2 until a system dryness of 25°F dewpoint was obtained, as verified by the Alnor dewpoint meter. Prior to leak checking the TCS, all bolts in the TCS panels were checked for proper torque, after ensuring that there were no open equipment-mounting bolt holes in the panels. The TCS was pressurized to 32 $\pm$1 psig with freon gas and checked for external leakage with the gaseous leak detector, P/N 1B37134-1. Areas checked for leakage included TCS B-nuts and fittings, manifold welded areas, boss welds, and manifold bellows. No leakage was detected. The freon was then purged from the TCS using GN_2 for a minimum period of 5 minutes.

The final operation consisted of disconnecting and securing the servicer and preparing the TCS for stage transfer to the VCL and ultimate shipment to FTC.

There were no FARR's initiated as a result of this checkout, and no discrepancies for the TCS were noted. Three revisions were recorded in the procedure for the following:

4.3.27 (Continued)

a. One revision specified that the normal supply temperature setting for the TCS servicer should be 60 $\pm 5^{\circ}F$.

b. One revision updated the obsolete identification of the facility GN_2 supply valve in the procedure.

c. One revision authorized removal of the differential pressure testing equipment and replumbing of the servicer to the TCS in preparation for a repeat run of all systems test procedure.

4.3.28 Telemetry and Range Safety Antenna System Check (1B44472 D)

During the AST checkout, the PCM RF assembly, P/N 1B52721-521, S/N 034, was replaced with S/N 011, per FARR 500-225-271. The replacement resulted in the issuance of this procedure to perform the required checkout of the new PCM RF assembly. This was satisfactorily accomplished on 12 June 1968. The items involved in this test included:

Part Name	P/N	Reference Location	S/N
PCM RF Assembly	1B52721-521	411A64A200	011
Bidirectional Coupler	1A69214-503	411A64A204	083
Forward Power Det.	1A74776-503	411MT728	2-0200
Dummy Load	1A84057-1	411A64A203	660

Stage power was turned on for the PCM transmitter test. A dummy load, P/N 1A84057-1, S/N 660, was connected to the output of the transmitter, and power was turned on to the PCM RF assembly. After allowing 3 minutes for transmitter warmup, a 5 vdc input signal was applied, and the output frequency was measured at 258.545 MHz. The frequency measurement was then repeated after reversing the polarity of the 5 vdc input. This repeat measurement was recorded as 258.477 MHz. The PCM transmitter center frequency was calculated by averaging the two measured frequencies, and the carrier deviation was calculated as one-half of the differential between the two measured frequencies. The resultant center frequency of 28.511 MHz and carrier deviation of 34.0 kHz were within the allowable limits of 258.500 $\pm$0.026 MHz and 36.0 $\pm$3.0 kHz, respectively. With the PCM transmitter reconnected to the system, the forward power detector output was measured and verified to be within $\pm$3 percent of the detector calibration requirement for the transmitter output power. No other checks were required to verify proper operation of the new PCM RF assembly, and it was accepted for use.

4.3.28 (Continued)

No problems were noted during this test, and no FARR's were initiated. One revision was recorded in the procedure which deleted all tests, except the PCM transmitter center frequency checks, carrier deviation checks, and the forward power detector calibration, which were required to verify the replacement PCM RF assembly.

4.4 Postmodification Retest

The postmodification retest operations were initiated on 23 October 1968, by the performance of the propulsion system leak checks, paragraph 4.4.1. Acceptance of the forward skirt thermoconditioning system checkout, paragraph 4.4.26, on 21 November 1968, completed the postmodification retest requirements as deliniated in the End Item Test Plan 1B66684, Advance E.O. L, dated 25 November 1968.

4.4.1 Propulsion Leak and Functional Check (1B71877 C)

This checkout procedure defined the operations required to perform the leak and functional checks which certified the stage propulsion system postmodification condition. Initiated on 23 October 1968, the checkout was completed and certified as acceptable on 20 November 1968.

The O_2H_2 burner was inspected for external signs of damage or loose equipment; and verification was made that the burner exciter cable connectors, 403W8P8 and 403W8P10, were connected to the spark exciter simulator, P/N 1B71782-1.

Visual observation of the spark gap for constant arcing was accomplished by sighting through the 9/16 inch diameter hole in the gauge assembly, P/N 1B67184-1, which was installed on the O_2H_2 burner adapter flange. This checkout was repeated for the second spark igniter, which satisfactorily completed the spark igniter arcing checks.

The umbilical quick-disconnect check valve leak test was accomplished by disconnecting to the tube assembly on the stage side of the umbilical; applying regulated helium to the stage side of the quick-disconnect; and measuring the leakage with a flow tester, P/N G-3104. The quick-disconnect check valves involved in this check were for the thrust chamber, the purge engine start bottle, the engine control sphere, the LOX tank repressurization supply, the LH_2 tank repressurization supply, the ambient helium fill, and the APS helium supply. One leakage condition was noted during this section. The aft umbilical quick-disconnect, No. 6, exhibited a reverse leakage of 0.43 scim, above the 0 scim tolerance. This tolerance was increased to 10 scim maximum by a revision to the procedure.

4.4.1 (Continued)

The calip pressure switch leak checks performed a decay check of the mainstage pressure switches by pressurizing the system to 400 ±10 psig through the J-2 customer connect panel, isolating the mainstage switches from the supply source, and monitoring decay for 15 minutes. All decay and leak checks were satisfactorily completed.

The LOX chilldown pump purge integrity test was accomplished by setting the stage 1 helium regulator at 950 ±25 psig and pressurizing the control helium sphere. The LOX chilldown pump purge control valve was opened, and the chilldown pump motor container was monitored for pressur increase and pressure switch pickup. Pressurizing of the motor container progressed until the relief valve activated and the container pressure stabilized. The motor container was monitored for 2 hours, and the pressure decay was noted and recorded. The test was concluded by venting the pump purge system to ambient.

The ambient helium system leak and flow check was accomplished next. This section performed a reverse leak check of the LOX and LH_2 fill and drain purge check valves and the LOX and LH_2 vent purge check valves. The internal leakage of the ambient helium fill module was checked during this test. Included in this section were the reverse leakage tests of the check valves for the ambient helium sphere fill system and the ambient LOX and LH_2 repressurization module. Internal leakage of the LOX and LH_2 repressurization module and the pneumatic power control module was also checked. IIS 440887 reported that the flow rate from the LOX fill and drain valve was 1.0 scim, as opposed to the 3.5 ±2 scim tolerance. The condition was acceptable to engineering. The flow

4.4.1 (Continued)

for the vent module bellows purge was stated on the same IIS as 38 scims, below the 75 ± 30 scim tolerance. This condition was also accepted by engineering.

The control helium system leak and functional checks consisted of an ambient helium system leak check and an actuation control module internal leakage check. The leak check log indicated a leak in the LOX shutdown valve in the pneumatic actuation control module, P/N 1B66639-515, S/N 045. FARR 500-489-421 removed and replaced the module. A second leak was repaired by retightening a B-nut. This completed this section.

The engine start system leak and functional test included a seat leakage check of the start tank control solenoid valve and a reverse leakage check of the start tank fill check valve. Leakage checks were performed on the GH_2 start system, the start tank dump control solenoid seal, and the vent and relief valves and valve bellows. Start bottle retention tests were conducted to measure the start bottle decay by calculating the pound-mass/hour loss.

LH_2 pressurization and repressurization system leak and functional checkouts included functional checks of the burner LH_2 repressurization control valves, reverse leakage tests of the burner LH_2 check valves, and leakage tests of the burner LH_2 repressurization control valve seat and pilot bleed repressurization system. This section also performed reverse leakage tests of the fuel pressure module check valve, the LH_2 pressurization redundant check valve, and the LH_2 prepressurization check valve.

4.4.1 (Continued)

Thrust chamber leak checks included the ignition probe, the LOX dome purge line from the purge port on the LOX dome to the GSE purge check valve, and the main fuel valve (MFV) and main oxidizer valve (MOV) idler and drive shaft seals. This section also covered reverse leakage tests of the LOX dome and thrust chamber purge check valves.

LOX pressurization and repressurization system leak and functional checkouts included internal leakage and functional checks of the LOX tank pressure control module, the burner LOX repressurization module, the LOX pressurization system burner LOX repressurization coil, and the burner and ambient repressurization system. Reverse leakage checks were performed on the cold sphere fill check valve, the LOX repressurization check valve, and the burner LOX repressurization check valve. This section also performed a leak check of the cold helium system, which included a reverse leakage check of the LOX tank prepressurization check valve. All tests were completed and accepted.

The LOX tank, O_2H_2 burner, and engine feed system leak checks were accomplished next. This section performed internal leakage checks of the engine feed system, which included the LOX prevalve, the LOX chilldown shutoff valve, and the LOX chilldown return check valve. The engine LOX bleed valve and MOV seat leakage checks, the LOX tank and engine feed system leak checks, the LOX turbopump torque checks, and the LOX chilldown pump purge flow checks were also accomplished. The LOX valve leakage checks were performed, including a shaft seal leakage check of the LOX prevalve and a seat leakage check of the LOX fill and drain valve. This section also covered a leak and flow check of the O_2H_2 burner LOX system, which included a leak check from the LOX tank to the burner LOX propulsion valve and seat leakage checks on the burner LOX propellant

4.4.1 (Continued)

and shutdown valves. The LOX prevalve and chilldown shutoff combined leakage was 2796.2 scim. The maximum allowable leakage was expressed as 150 scim. Investigation revealed the discrepancy was due to excessive internal leakage. The prevalve was removed and replaced on FARR 500-489-286.

The LH_2 tank O_2H_2 burner and engine feed system leak checks performed external and internal leakage checks of the engine feed system, which included the LH_2 chilldown return check valve, the LH_2 prevalve, the LH_2 chilldown shutoff valve, the engine LH_2 bleed valve, the engine MFV, and the LH_2 fill and drain valve. Reverse flow leakage tests were performed on the LH_2 chilldown return check valve, the LH_2 pump drain and purge check valves, and the LOX and LH_2 turbine seal cavity purge check valves. A forward check was performed on the LH_2 pump drain check valve. Seal leakage checks were performed on the LH_2 prevalve shaft and turbopump primary seal with the turbopump running. This leakage test included a breakaway torque check.

This section also performed a leak and a flow check of the O_2H_2 burner LH_2 system and chamber, and included seat leakage checks of the burner LH_2 propellant valve shutdown valve. Six leakage conditions were found, two were repaired by replacement of seals, and four required retightening the coupling to the correct torque value.

The engine gas generator and exhaust system leak and flow test checked the gas generator purge check valve reverse leakage and the LH_2 and LOX turbine seal cavity bleed flow. The start tank discharge valve gate seal leakage was checked. The gas generator and exhaust system were checked for leaks, and the gas generator LOX purge check valve and LOX poppet valves were checked for

4.4.1 (Continued)

reverse leakage. Seal leakage checks were made for the hydraulic pump seal and the gas generator LOX and LH_2 propellant valve seats. The purge system leak checks were accomplished during this section of the test.

The next series of tests included engine pump purge module internal leakage and regulation checks, engine pump purge system leak checks, and flow rate checks of the gas generator fuel purge, LOX and LH_2 turbine seal cavity bleed, and fuel seal cavity purge systems.

The engine pneumatics leak and flow check executed leak checks of the helium control solenoid circuit, the pneumatic package, the circuits from the normally open ports of the ignition phase and mainstage solenoids, the pressure actuated purge system, the pressure actuated fast shutdown valves diaphragm, and the internal pneumatic components. The LOX pump intermediate seal was checked for leaks, and a flow check was accomplished on the cracking check valve overboard flow. Seat leakage tests were made on the ignition phase solenoid normally closed circuit, the start tank discharge valve solenoid (closed position), the start tank discharge valve piston seal (closed position), and the internal pneumatic components. The open positions of the start tank discharge valve solenoid and piston seal were accomplished, followed by a leak check of the start tank discharge valve solenoid circuit. The mainstage solenoid normally closed circuit and the pressure actuated fast shutdown valve were then leak checked. The engine control bottle and the fill line to the pneumatic package high pressure relief valve were leak checked. The engine control bottle fill check valve was tested for reverse leakage.

4.4.1 (Continued)

The LOX and LH_2 vent system leak and flow checks included the LOX vent system leak check and the LH_2 ground and flight vent system leak checks. Also, the LOX vent and relief valve, the LH_2 vent and relief valve, and the LH_2 continuous vent valve were tested for internal leakage. The LH_2 propellant vent ducting was checked for leaks, and the LH_2 continuous vent module was checked for internal leakage. The LH_2 nonpropulsive vent and ground systems vents were leak checked, the LH_2 vent and relief valve and the directional vent valve were checked for internal leakage, and the LH_2 directional vent actuator was checked for piston leakage.

Ten leakage conditions were reported in the leak check log. Four leaks were corrected by retightening, three required replacement of seals, and two were acceptable as the leakage was not in excess of the maximum allowance.

Eighty-three revisions were written to this procedure for the following:

a. Forty-eight revisions concerned changes that were required to update or correct the procedure for postmodification retest.

b. Twenty revisions added or repeated steps to insure post-modification systems integrity.

c. One revision added a special leak check procedure for the low pressure duct gimbal joints.

d. One revision outlined a method of preventing damage to the pneumatic regulator.

e. One revision changed the maximum allowable leakage for the hot gas bypass valve and pilot valve leakage from 3000 scim to 1000 scim.

f. One revision added a step to increase the volume of helium to the thrust chamber.

4.4.1 (Continued)

g. One revision provided instructions to prevent possible damage to the LH_2 prevalve.

h. One revision authorized the use of a substitute part.

i. One revision provided for LOX tank low point sampling with the umbilical not connected.

j. One revision changed a callout for a 0-100 psig test gauge to a 0-1000 psia test gauge, to increase the flow rate to maintain a 45 ± 2 psia in the LOX low pressure duct.

k. One revision provided a method of isolating a leak source to either the LOX chilldown shutoff valve or the LOX prevalve.

l. One revision outlined instructions for venting the LH_2 tank, if necessary, during leak checks.

m. One revision authorized a test setup to support a special flow check of the GG LOX injector purge system.

n. One revision changed the maximum allowable leakage on the No. 6 quick disconnect from 0 scim to 10 scim.

o. One revision attributed three apparent malfunctions to a momentary dual talk indication. Valve operation was satisfactory and did not affect the program.

p. One revision stated that three out-of-tolerance conditions were due to a hardwire drag-in cable, P/N 1B49399-2, being removed, resulting in loss of talkback indications.

q. One revision performed the leak and functional check of the LOX prevalve after installation of the replacement prevalve per FARR 500-489-286.

4.4.1.1 Test Data Table, Propulsion Leak and Functional Check

Umbilical Quick Disconnect Check Valve Leak Check

Function	Measurement	Limits
Thrust Chamber Purge (scim)	0.0	0 max
Engine Start Bottle Supply (scim)	0.0	0 max
Engine Control Supply (scim)	0.0	0 max
LOX Prepress Supply (scim)	0.42	10 max
LH_2 Prepress Supply, High Press (scim)	0.0	0 max
LH_2 Prepress Supply, Low Press (scim)	0.0	0 max
Repress Bottle Supply (scim)	0.0	0 max

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-499 (Cont.)	b. Pin E of receptacle J2 on the 404MT735B amplifier, P/N 1A88852-503, S/N 318, at the 404A70 panel, was bent approximately 40°.	b. The pin was straightened with a type 555 pin straightener. NOTE: The system will be functionally checked per 1B73601 at FTC.
500-489-502 11-26-68	a. During performance of 1B64681, it was noted that pin N of the J1 receptacle on the 404A68A203 module, P/N 1A84763 -511, S/N 0151, was bent.	a. The pin was straightened with a type 555 pin straightened.
	b. The 404A68A203 cable, P/N 1B76206-1, had a punctured insert adjacent to socket N of connector P3.	b. The damaged connector was removed and replaced. NOTE: The system will be functionally checked per 1B73601 at FTC.
500-489-529 11-8-68	The threaded insert in fastener, P/N 1B28715-1, was missing from the 411A92 forward skirt thermoconditioning panel, P/N 1A98142-501, S/N 0027. The missing insert was approximately 18 inches forward and 20 3/16 inches from the left side of the panel.	The insert was replaced and bonded per 1A98142.
500-489-537 11-15-68	The curtain assembly, P/N 1B69815-A45-3-9, was not reworked to the A45-3 change. Per 1B65607, zone 4, the main view dimension was approximately 89.00 and should have been 90.89. The main view dimension per zone 5 is approximately 66.00 and should have been 67.77.	The curtain assembly was removed and replaced.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-570 11-18-68	During performance of 1A39300, job 13, per 1A39322, zone M, view C-C, it was noted that the insulation, P/N 9709132, was debonded from the LH_2 duct, P/N 1A39301, at the end over the LH_2 prevalve.	The damaged insulation was acceptable to the Material Review Board.
500-489-561 11-18-68	During system check, it was noted that the J-4 receptacle on the range safety decoder had the following defects: a. One pin was bent 90 degrees. b. One pin was bent 45 degrees and was shorting an adjacent pin which was bent 30 degrees. c. Four pins were slightly bent. NOTE: The above pins were not identified by letter or number.	The decoder was removed and replaced.
500-489-588 11-19-68	a. During rework per 1B75982-1, it was noted that the P28 connector insert of cable, P/N 1B75982-1, at the 404A3 sequencer, was punctured between a, s, and T, adjacent to DD. b. Pin t of receptacle J28, at the 404A3 sequencer, was bent.	a. The connector was removed and replaced. b. The bent pin in receptacle J28 was straightened per DPS 54002. NOTE: The system will be functionally checked at FTC.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-596 11-18-68	During routine inspection per 1B58006, zone 3, view AV-AV, the pipe assembly, P/N 1B76051-1, was distorted and bent at the adapter, P/N MC237C4W, end.	The pipe assembly was removed and replaced.
500-489-600 11-20-68	During rework per 1B75982-1J, it was noted that the retainer ring for the rubber insert at connector P42 of cable assembly, P/N 1B75982-1, was bent and distorted between the two guide pins.	The condition was acceptable to the Material Review Board for use.
500-489-618 11-20-68	During performance of 1B41005, paragraph 4.2.1.4, it was noted that both the pitch and yaw actuator shafts had numerous small scratches and dents in the midstroke lock grooves.	The scratches were smoothed and polished out. The dents were acceptable to the Material Review Board.
500-489-626 11-20-68	During performance of 1B73601, it was noted that parameters E211 and E225 of the channel calibration decoder, P/N 1A74053-503, S/N 115, at the 404A71A206 panel, failed to receive remote automatic calibration.	The decoder was removed and replaced. NOTE: The system will be functionally checked per 1B62753 at FTC.
500-489-634 11-20-68	During performance of 1B73601, paragraph 4.1.69, it was noted that the 411A60A203 vibration multiplexer, P/N 1B32686-509 S/N 02, measurement No. S102 through S107, had no output.	The vibration multiplexer was removed. The disposition was given to resubmit the condition at FTC Material Review Board for further action.
500-489-642 11-20-68	During rework of 1A75985-1E, it was noted that the 411A99A10W1 cable, P/N 1B75985-1E, had a wire, R221A20, with a 1/8 inch split in the insulation exposing the wire strands just aft of connector P52 backshell.	The wire was removed, replaced, and tested per 1B75985.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-669 11-21-68	During preshipment inspection, it was noted that 17 nyafil standoffs in the thrust structure, aft skirt, and main tunnel areas had stripped threads.	The inserts were removed and replaced per 1B53312.
500-489-693 11-21-68	During performance of 1B73601, it was noted that the 401MT664A vibration combustion dome measurement No. E251 was 0 vpp and should have been 1.4 $\pm$0.5 vpp.	The disposition was given to resubmit the condition at FTC Material Review Board for further action.
500-489-723 11-22-68	During the final inspection, the following discrepancies were noted:	
	a. There was insufficient clearance between the convolutions of the continuous vent duct, P/N 1B44575-502, between stringers 95 and 103.	a. The attach and securing bolts for the continuous vent duct were released, and the flex elbow was rotated to relieve the preload. Two 6061-T6 shims were added between the duct and the mounting clamp at stringer 103. The mounting holes at stringer 95 were slotted to accept the clamp without preloading the duct.
	b. Several areas of corrosion were found on the O_2H_2 burner.	b, c, and d. The conditions were acceptable without rework.
	c. Many areas of corrosion were noted on the stainless steel throughout the 403 external area.	
	d. Oxidation was noted on the LOX and LH_2 low pressure ducts, the LOX chilldown return line, and the tube assembly, P/N 1B75818-1, on the stage side of the customer connect panel.	

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-607-262 9-26-68	After removal of the LOX probe from the stage, a small dent approximately 1/16 inch deep was noted in the Deutsch connector, P/N 1B37872-511, S/N 1410, on wire harness, P/N 1B67152-1, reference location 404W30P6.	The damaged connector was removed and replaced. Retest was accomplished per the PU calibration procedure and PU automatic procedure.
500-607-271 9-26-68	This is a Production requested FARR. Cable assembly, P/N 1B76000, reference location 404W207, was short on branch to plug P47 at panel 404A72A202. The cable should have broken out of main cable at stringer 93, but breakout was at stringer 100. This resulted in the cable being approximately 5 inches too short. The breakout consisted of 16 wires.	The 16 noted wires were removed from the cable and replaced. The cable assembly was tested per 1B76000.
500-607-297 10-11-68	Fuel continuous vent duct assembly, P/N 1B75174-501, S/N 314, was not installed per 1B74943, view M. The 3.74 inch dimension should have been 4.20 $\pm$0.25 inches; also per 1B75174, zone 6, the 3.67 inch dimension should have been 3.75 $\pm$0.03 inches; and per zone 15, the 5.64 inch dimension should have been 5.44 $\pm$0.03 inches. The 12° dimension should have been 10° $\pm$30'.	The duct assembly was removed, reworked, and reidentified per 1B74940-A45-1. The duct assembly was reinstalled and leak checked per 1B71877.
500-607-301 10-14-68	The 404W207 wire harness, P/N 1B76000-1, breakout point to connectors P40, P54, P55, P56, P57, P58, P59, P60, P61, and P63 was at stringer 96 and should have been at stringer 93. This condition caused the harness to be approximately 3 feet too long.	The existing breakout was acceptable to the Material Review Board. The excess length was cut off, and the connectors were reterminated and tested per 1B75537 and 1B55820.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-607-319 10-16-68	During installation of the 404W207 wire harness, P/N 1B76000-1, it was noted that the retro-rocket heat impingement curtain, P/N 1B65109, had ten 3/16 inch bolt holes drilled with blind nuts installed through retainer, P/N 1B65778-515, per 1A39301, zone 14, view J, and should have been NAS nuts per zone 55, view CA for the -503 configuration, stage 1010. NOTE: This condition would not allow the wire harness to be routed through support openings.	The blind nut installation was accepted by the Material Review Board. The 404W207P35 through P39 connectors were removed, and the harness was routed through the support openings. The connectors were reinstalled and tested per 1B75537 and 1B55820
500-607-343 10-22-68	During installation of the fuel mass probe, P/N 1A48431-513, S/N D4, it was noted that brown paper packages of dessicant crystals, with paper masking tape to secure the packages inside the clean polyethylene bag, were used. Also, the bag had several holes near the aft end of the probe.	The exterior of the probe was wiped down with instrument wiping cloths dampened with freon PCA.
500-607-351 11-6-68	The right top of support, P/N 1B37428-513, was broken off where the adhesive attached to the 404A70 panel, P/N 1B51291-507. NOTE: Reference 1B51291, zone 3.	The support was removed by applying heat to a maximum of 300°F. A new support was installed per 1B51291.
500-607-360 10-23-68	During rework per FARR 500-372-575, the area between stringers 66 and 67 was not touched up per DPS 42210. NOTE: This area was located in the center of an ablated coated area.	The surface was cleaned with freon, the rivet heads and exposed doubler were sealed with RTV1200 primer, the surface was treated with treating agent 92-035 and a layer 0.1 to 0.2 inch thickness of 93-044 silicone insulation and feathered into existing flight paint.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-607-459 10-29-68	The 411A90A204 module, P/N 1B42212-1, S/N 017, receptacle J2 pin C was bent.	The pin was straightened per DPS 54002, paragraph 62, and retested per 1B73601.
500-607-467 10-29-68	Connector P24 of the 411W210 wire harness, P/N 1B76064-403, S/N 5242, had a puncture in the environmental seal adjacent to sockets B and C.	Connector P24 was removed, replaced, and tested per 1B73601.
500-607-475 10-29-68	The 411MT753A transducer coaxial receptacle on sensor, P/N 1A68707, S/N 116, was broken.	The sensor was removed. The sensor will be installed and tested at FTC.
500-607-483 10-30-68	During rework per 1A79615 and WRO 4592, it was noted that support assembly, P/N 1B31257-505, between stiffeners 8A and 9 supporting transducer, 403MT709, was distorted due to omitted hardware from a previous installation.	The support assembly was removed and replaced.
500-607-491 10-31-68	During verification of the transducer kit installation, it was noted that aft skirt wire bundle support, P/N 1B62907-69A, installed on the 404A70A1 panel, P/N 1B53666-541, had stripped threads per 1B62907, zone 18.	The support assembly was repaired per 1B53312.
500-607-505 10-31-68	During performance of AO 1B57452BM, the 410MT601B cable assembly, P/N 1B40242-55, S/N 509-15, was badly frayed exposing bare sheilding for an area 2 1/2 feet in length.	The cable assembly was removed and replaced.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-608-285 11-25-68	The following discrepant conditions were found on the common bulkhead during inspection of the LH_2 tank interior a. Five bare areas in the anodizing on the common bulkhead. b. Seven areas of tool chatter marks from 2 1/2 to 20 inches long in the anodizing. c. Insulation tiles number 278 and 325 were loose. d. A 1 inch diameter debond forward of tile No. 10 on the forward dome. e. A crack in the tile around the forward edge of the main diffuser.	All items were acceptable without rework.
500-608-293 11-26-68	During the final acceptance inspection, it was noted that cable assembly, P/N 1B58252-1, was damaged in two places. In both cases, the insulation was cut through to the cable shielding. One of the cuts severed five shield strands.	The damaged insulation was removed above and below the damaged areas, and the broken strands were withdrawn. The area was then overwrapped with 3 layers of DPS 2766 tape, the loose shield strands were then folded back, and a final wrap of 4 layers of tape was applied and fused with a 100 watt soldering iron.
500-608-307 11-26-68	During inspection documentation, it was noted that the LH_2 mass sensing probe, P/N 1A48431-513-009, S/N D4, had no evidence of cleaning per MFSC 164, prior to reinstallation.	The sensing probe was disassembled, routed to the LOX lab, cleaned per DPS 43000-1, and reinstalled. NOTE: The system will be leak checked per 1B71877 and functionally checked per 1B55823 at FTC.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-608-323 11-29-68	During the performance of the preshipment purge, it was noted that electrical receptacle 404A4J5 had a hole in the rubber insert near pin i.	The Material Review Board accepted the receptacle for use.

APPENDIX III

FLIGHT CRITICAL ITEMS

APPENDIX III

FLIGHT CRITICAL ITEMS INSTALLED AT TURNOVER

The flight critical items (FCI), as designated by DRD 1B53279J, that were installed on the stage at the time of turnover to NASA/STC for shipment to KSC are listed in the following tabulation:

P/N	S/N	Ref. Location	Name
1A48240-505-007	0044	404A7	Fill and drain valve
1A48240-505-007	0127	427A8	Fill and drain valve
1A48257-525	0068	411A1	LH_2 vent and relief valve
1A48312-513	0051	424A1	LOX vent and relief valve
1A48430-509-011	D9	406A1	LOX mass probe
1A48431-513-009	D4	408A1	LH_2 mass probe
1A48857-501	43	403A73	Control helium tank
1A48858-1	1012	Bnk 2 Pos 9	Helium sphere, cold
1A48858-1	1127	Bnk 1 Pos 3	Helium sphere, cold
1A48858-1	1132	Bnk 2 Pos 8	Helium sphere, cold
1A48858-1	1139	Bnk 1 Pos 4	Helium sphere, cold
1A48858-1	1146	Bnk 2 Pos 7	Helium sphere, cold
1A48858-1	1160	Bnk 1 Pos 5	Helium sphere, cold
1A48858-1	1161	Bnk 1 Pos 2	Helium sphere, cold
1A48858-1	1164	Bnk 1 Pos 1	Helium sphere, cold
1A48858-1	1167	Bnk 2 Pos 10	Helium sphere, cold
1A49421-507	207	427A3	LH_2 aux chilldown pump
1A49423-509	1388	424A4	LOX aux chilldown pump
1A49964-501	222	424 (LOX)	Chill system check valve
1A49964-501	265	427 (LH_2)	Chill system check valve
1A49965-523-012	0506	424A41	Chill system shutoff valve
1A49965-525-013B	0507	424A4	Chill system shutoff valve
1A49968-519	123	404A44	Prop. tank shutoff valve
1A49968-521	150	424A6	Prop. tank shutoff valve
1A49988-513	0036	411A29	LH_2 directional vent valve
1A49991-1	047	403A74	Tank, comp. gas, cold helium
1A49991-1	58	403A6	Tank, comp. gas, cold helium
1A57350-507	0232	403A73A13	Helium fill module
1A58345-523	1034	403A73A1	Module, pneumatic pwr control
1A58347-513	05	403A75A2	Engine pump prg cont mod
1A59358-525	00004	411A92A6	PU electronics assembly
1A66212-507	025	411A92A7	Inv-conv elect. assy
1A66240-503	X457808	401A11S1, S2	Engine driven pump, hydraulic
1A66241-511	X454588	403B1	Aux hydraulic pump
1A66248-505-011A	51	403A71L1	Hydraulic actuator assy
1A66248-505-011A	53	403A72L1	Hydraulic actuator assy
1A68085-505	0108	411A99A10A1	300 amp pwr transfer switch

Appendix III (Continued)

P/N	S/N	Ref. Location	Name
1A68085-505	0098	404A45A1	300 amp pwr transfer switch
1A68085-505	0101	404A2A1	300 amp pwr transfer switch
1A74039-517-011E	00037	404A74A2	Chilldown inv. elect. assy
1A74039-517-011E	00039	404A74A1	Chilldown inv. elect. assy
1A74211-505	0424	404A2A6	2 amp relay module
1A74216-503	0465	411A99A10A6	Mag latch relay module
1A74216-503	0488	404A45A5	Mag latch relay module
1A74218-505	0490	404A2A2	10 amp relay module
1A74765-507	224	401A11S1	Hyd syst thermal switch
1A74890-501	0121	404A2A7	50 amp relay module
1A74890-501	00117	404A45A2	50 amp relay module
1A74890-501	0124	404A2A10	50 amp relay module
1A74890-501	0125	411A99A10A2	50 amp relay module
1A74890-501	0123	404A2A9	50 amp relay module
1A77310-503.1	0103	411A98A2	5 volt excitation module
1A77310-503.1	0170	411A99A33	5 volt excitation module
1A77310-503.1	0171	404A52A200	5 volt excitation module
1A86847-509	059	401A11S1, S2	Hyd pump thermal isol assy
1B29319-519	00034	403A46	Accum/reservoir assy
1B32647-505	068	404A45A3	Hyd pwr unit start switch
1B33084-503	013	411A97A19	RS controller assy
1B33084-503	014	411A97A13	RS controller assy
1B39037-501	4	401	Eng installation bolts
1B39037-501	32	401	Eng installation bolts
1B39037-501	57	401	Eng installation bolts
1B39037-501	202	401	Eng installation bolts
1B39037-501	203	401	Eng installation bolts
1B39037-501	204	401	Eng installation bolts
1B39550-515	009	404A3	Sequencer mounting assy
1B39975-501	0237	404A2A16	Diode module
1B39975-501	0239	404A2A17	Diode module
1B40604-1.2	083	404A2A34	Diode assy module
1B40604-1.2	051	404A2A18	Diode assy module
1B40604-1.2	0110	404A3A51	Diode assy module
1B40604-1.2	0113	404A3A50	Diode assy module
1B40824-507.1	110	403 Str 9A	Check valve
1B40824-507.1	108	403 Str 9-3/4	Check valve
1B40824-507.1	126	403 Str 6A	Check valve
1B40824-507.1	117	403A74A4	Check valve
1B40887-501	0291	404A2A15	10 amp mag latch relay mod
1B40887-501	0306	404A45A6	10 amp mag latch relay mod
1B40887-501	0259	411A99A10A4	10 amp mag latch relay mod
1B40887-501	0213	411A99A10A5	10 amp mag latch relay mod
1B40887-501	0305	404A3A16	10 amp mag latch relay mod
1B40887-501	0354	404A3A57	10 amp mag latch relay mod
1B40887-501	0556	404A3A58	10 amp mag latch relay mod

Appendix III (Continued)

P/N	S/N	Ref. Location	Name
1B42290-507	0043	403A74A1	LOX press. control module
1B51211-505	011	404A45	Aft 56 volt pwr dist assy
1B51354-507	09	404A2	Aft 28 volt pwr dist assy
1B51379-511	08	411A99A10	Fwd pwr dist mount assy
1B51753-511	026	411A32	LH_2 prop vent reg & S/D valve
1B52623-515	008	403S2	Pressure switch
1B52624-511	035	411S2	Pressure switch
1B52624-511	025	411S4	Pressure switch
1B52624-515	26	403S8	Pressure switch
1B52624-519	44	403S1	Pressure switch
1B52624-519	51	403S5	Pressure switch
1B52624-519	52	403S6	Pressure switch
1B53920-501	037	403A73	Chill feed duct check valve
1B53920-503	047	LOX C/D duct	Chill feed duct check valve
1B53920-503	070	LH_2 C/D duct	Chill feed duct check valve
1B55408-503	00018	Str 13-14	Compressed air tank
1B57731-501	417	404A71A19	Control relay package
1B57731-501	418	404A51A4	Control relay package
1B57781-507	027	403A74A2	Cold helium fill module
1B58006-401	47	403A74	1A49991, teflon wrapped
1B59010-509	125	427A7	Pneu prop. control valve
1B62600-527-012	08	403 Str 10-3/4	O_2H_2 welded burner assy
1B62778-503	00008	403A7	Helium plenum & valve assy
1B62778-503	024	403A6	Helium plenum & valve assy
1B65319-503	013	404A70A1	Sw sel emissivity cont assy
1B65673-1	23	403A13 Str 6	Cold helium check valve
1B66230-509	1034	403A73A3	Calibrated LH_2 press. cont mod
1B66639-515	46	403	Pneu latching actuator assy
1B66639-519	032	411A32	Pneu latching actuator assy
1B66692-501-A45-1	27	404A44	Actuation control module
1B66692-501-A45-1	25	404A43	Actuation control module
1B66692-501-A45-1	84	403A15	Actuation control module
1B66692-501-A45-1	35	411A30	Actuation control module
1B66692-501-A45-1	85	404A17	Actuation control module
1B66692-501-A45-1	24	403A75A1	Actuation control module
1B66692-501-A45-1	26	404A9	Actuation control module
1B66692-501-A45-1	33	411A2	Actuation control module
1B66692-501-A45-1	32	411A3	Actuation control module
1B66692-501	151	403A8	Actuation control module
1B66692-501	169	411A14	Actuation control module
1B66868-501	09	Pos 8 Str 20	Ambient helium sphere
1B66868-501	10	Pos 9 Str 23	Ambient helium sphere
1B66868-501	011	Pos 10 Str 24A	Ambient helium sphere
1B66868-501	013	Pos 1 Str 6A	Ambient helium sphere
1B66868-501	014	Pos 2 Str 7A	Ambient helium sphere
1B66868-501	016	Pos 7 Str 18	Ambient helium sphere
1B66868-501	017	Pos 6 Str 17	Ambient helium sphere
1B66868-501	019	Pos 5 Str 12	Ambient helium sphere

Appendix III (Continued)

P/N	S/N	Ref. Location	Name
1B67193-511	044	411A32	Continuous vent control mod
1B67481-1	804159	411A14L2	Check valve, 1/4" vent port
1B67481-1	804158	411A14L1	Check valve, 1/4" vent port
1B67481-1	70621101	411A3L1	Check valve, 1/4" vent port
1B67481-1	70621102	403A15L2	Check valve, 1/4" vent port
1B67481-1	70621116	404A44L2	Check valve, 1/4" vent port
1B67481-1	70621143	404A17L1	Check valve, 1/4" vent port
1B67481-1	70621147	403A75A1L2	Check valve, 1/4" vent port
1B67481-1	70621173	411A2L2	Check valve, 1/4" vent port
1B67481-1	70621195	403A74A1	Check valve, 1/4" vent port
1B67481-1	70621196	404A17L2	Check valve, 1/4" vent port
1B67481-1	70621208	404A44L1	Check valve, 1/4" vent port
1B67481-1	70621209	404A43L1	Check valve, 1/4" vent port
1B67481-1	70621214	403A75A1L1	Check valve, 1/4" vent port
1B67481-1	70621256	403A8L1	Check valve, 1/4" vent port
1B67481-1	70621279	403A8L2	Check valve, 1/4" vent port
1B67481-1	70621300	403 Str 20	Check valve, 1/4" vent port
1B67481-1	7062133	403A74A2L1	Check valve, 1/4" vent port
1B67481-1	7062153	404A9L1	Check valve, 1/4" vent port
1B67481-1	7062156	411A3L2	Check valve, 1/4" vent port
1B67481-1	7062160	403A15L1	Check valve, 1/4" vent port
1B67481-1	7062165	411A30L2	Check valve, 1/4" vent port
1B67481-1	7062173	411A30L1	Check valve, 1/4" vent port
1B67481-1	7062174	404A9L2	Check valve, 1/4" vent port
1B67481-1	7062189	404A43L2	Check valve, 1/4" vent port
1B67481-1	7062191	411A2L1	Check valve, 1/4" vent port
1B67481-1	8010550	403A73A1L1	Check valve, 1/4" vent port
1B67481-1	8082835	403A74A2	Check valve, 1/4" vent port
1B67598-501	104	403 Str 6	Pneumatic check valve
1B67598-501	105	403 Str 18	Pneumatic check valve
1B67598-501	106	404 Str 28A	Pneumatic check valve
1B67598-501	107	LOX F&D	Pneumatic check valve
1B67598-501	110	403A73A4	Pneumatic check valve
1B67598-501	126	LH_2 F&D	Pneumatic check valve
1B67598-503	73	--	Pneumatic check valve
1B69030-501	0022	424A9	LOX NPV control valve
1B69514-501	07	404A3A56	Isolation diode module
1B69514-501	09	404A9	Isolation diode module
1B69514-501	011	404A11	Isolation diode module
1B69514-501	021	411A99A8	Isolation diode module
1B69514-501	031	404A3A55	Isolation diode module
1B69550-501	031	403A73A4	Repress. control module
1B69550-501	030	403A74A3	Repress. control module

Appendix III (Continued)

P/N	S/N	Ref. Location	Name
7851823-503	1060	Pos 2 at umb	Helium control disconnect
7851823-503	1084	Pos 1 at umb	Helium control disconnect
7851844-501	62	10" from F&D	Cold helium disconnect
7851861-1	57	427	LH_2 tank press. disconnect
40M39515-113	277	404A75A1	EBW firing unit
40M39515-113	283	404A75A2	EBW firing unit
40M39515-113	282	404A47A2	EBW firing unit
40M39515-113	285	404A47A1	EBW firing unit
40M39515-119	451	411A99A12	EBW firing unit
40M39515-119	450	411A99A20	EBW firing unit
103826	J-2091	401	J-2 engine

4.4.1.1 (Continued)

Module Relief and Internal Leakage Test

Cold Helium Fill Module - P/N 1B57781-507, S/N 0027

Function	Measurement	Limits
Relief Valve Seat Leakage	0	Max Combined Leakage at
Dump Sol Seat Leakage (scim)	0	3100 $\pm$100 psig - 5 scim
Relief Valve Seat Leakage (scim)	0	Max Combined Leakage at
Dump Sol Seal Leakage (scim)	0	300 $\pm$50 psig - 18 scim

Calip Pressure Switch Leak Checks

Function	Measurement	Limits
Low Press Sw C/O Circuit Decay (psi)	1.0	0.5 max/5 minutes
Eng Mnstg Press Sw Diaph Decay:		
Initial (psig)	400.0	*
Final (psig)	392.0	*
Decay (psi)	8.0	10.0 max/15 minutes
Mnstg Press Sw C/O Circuit Decay (psi)	4.6	5.0 max/5 minutes

Ambient Helium System Flow Checks

Function	Measurement	Limits
O_2H_2 LOX S/D Vlv Bellow Purge (scim)	45.0	70 $\pm$ 30
O_2H_2 LOX S/D Vlv Microsw Housing Flow (scim)	1.5	3.5 $\pm$ 2
LOX Tnk Ullage Sense Line Purge (scim)	265.0	432 $\pm$ 245
LOX F&D Vlv Microsw Housing Purge (scim)	1.9	3.5 $\pm$ 2
LH_2 F&D Vlv Microsw Housing Purge (scim)	1.0	3.5 $\pm$ 2
LH_2 C/D Shutoff Vlv Microsw Purge (scim)	5150.0	6500 $\pm$ 2450
LH_2 Prop Vlv Microsw Purge (scim)	1.5	3.5 $\pm$ 2
Nonpropulsive Vent Duct Purge (scim)	265.0	432 $\pm$ 245
Continuous Vent Module Purge (scim)	38.0	70 $\pm$ 40
Orifice Bypass Vlv Microsw Purge (scim)	1.9	3.5 $\pm$ 2
Continuous Vent Duct Purge (scim)	225.0	432 $\pm$ 245

Purge System Check Valve Reverse Leak Checks (P/N 1B67598-501)

Function	S/N	Measurement	Limits
LOX Vent Purge (scim)	105	0.0	10 max
LOX Fill & Drain Purge (scim)	107	0.0	10 max
LH_2 Fill & Drain Purge (scim)	106	0.0	10 max
LH_2 Vent Purge (scim)	126	0.0	10 max

* Limits Not Specified

4.4.1.1 (Continued)

Ambient Helium Fill Module Internal Leak Checks (P/N 1A57350-507, S/N 0232)

Function	Measurement	Limits
Amb He Fill Module C/V Rev Lkg (scim)	0.0	0 max
Amb He Fill Module Dump Vlv Seat Lkg (scim)	0.0	0 max

Ambient He Spheres Fill System Check Valves Reverse Leak Checks (P/N 1B67598-501)

Function	S/N	Measurement	Limits
LOX Repress Mod Ck Vlv (scim)	-	0.0	10 max
LH Repress Mod Backup Check Valve (scim)	110	0.0	10 max
LH Repress Mod Ck Vlv (scim)	-	0.0	10 max
He Fill Mod Backup Check Valve (scim)	104	0.0	10 max

Ambient Repress Module Control Valve Functional Checks

LOX Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0.0	*
Cont Vlv (L2) Seat Leakage (scim)	0.0	*
Module Dump Vlv Seat Lkg (scim)	0.0	*
Mod Dump Vlv Pilot Bleed (scim)	0.0	*
Mod Dump Vlv Seat & Pilot Bleed Lkg (scim)	0.0	9 max
Cont Vlv (L2) Pilot Bleed Lkg (scim)	0.0	*
Cont Vlv (L2) Seat & Pilot Bleed Lkg (scim)	0.0	9 max
Cont Vlv (L3) Pilot Bleed Lkg (scim)	0.0	*
Cont Vlv (L3) Seat & Pilot Bleed Lkg (scim)	0.0	9 max

LH_2 Repress System

Function	Measurement	Limits
Cont Vlv (L3) Seat Leakage (scim)	0.0	*
Cont Vlv (L2) Seat Leakage (scim)	0.0	*
Module Dump Vlv Seat Leakage (scim)	0.0	*
Mod Dump Vlv Pilot Bleed Lkg (scim)	0.0	*
Mod Dump Vlv Seat & Pilot Bleed Lkg (scim)	0.0	9 max
Mod Cont Vlv (L2) Pilot Bleed Lkg (scim)	0.0	*
Cont Vlv (L2) Seat & Pilot Bleed Lkg (scim)	0.0	9 max
Cont Vlv (L3) Pilot Bleed Leakage (scim)	0.0	*
Cont Vlv (L3) Seat & Pilot Bleed Lkg (scim)	0.0	9 max

* Limits Not Specified

4.4.1.1 (Continued)

Pneumatic Power Control Module Internal Leak Check (P/N 1A58345-523, S/N 1034)

Function	Measurement	Limits
Control He Shutoff Seat Leakage (scim)	0.2	10. max
Control Module Reg Lockup Press (scim)	530.0	550.0 max

Actuation Control Module Checks (P/N 1B66692-501)

Function	S/N	Normal	Open	Closed	Limits
O_2H_2 Burner LOX Vlv Control (scim)	84	0.0	0.0	0.0	6 max
O_2H_2 Burner LH_2 Vlv Control (scim)	85	0.0	0.0	0.0	6 max
Orificed Bypass Vlv Control (scim)	130	0.0	0.0	0.0	6 max
O_2H_2 Burner LH_2 Vlv/LOX S/D Vlv (scim)	85	0.0	0.0	0.0	6 max
		Normal	**Open**	**Boost**	
LOX Vent Vlv Control (scim)	24	0.0	0.0	0.0	6 max
LH_2 Fill & Drain Vlv Control (scim)	27	0.0	0.0	0.0	6 max
LOX Fill & Drain Vlv Control (scim)	26	0.0	0.0	0.0	6 max
LH_2 Vent Vlv Control (scim)	33	0.0	0.0	0.6	6 max
			Open	**Closed**	
LH_2 F&D Act Seal Leakage (scim)	27		0.0	0.0	350 max
LOX F&D Act Seal Leakage (scim)	26		0.0	0.0	350 max
LOX S/D Vlv Act Piston & Shaft Seal Leakage (scim)	-		0.0	0.0	20 max
LH_2 Control Vent Act Piston & Shaft Seal Leakage (scim)	-		0.0	0.0	20 max
LOX NPV Act Control (scim)	151		0.4	0.0	6 max
			Normal	**Closed**	
Prevlv C/D Vlv Act Control (scim)	25		0.0	-	6 max
Prevlv Act Control (scim)	-		-	0.6	6 max
C/D Act Control (scim)	-		-	0.0	6 max
Prevlv Microsw Housing (scim)	-		0.4	0.0	20 max
		Normal	**Flight**	**Ground**	
Bidirect Vent Vlv Act Control (scim)	126	0.0	0.0	0.0	6 max
		Normal	**Open**	**Latching**	
LH_2 Latching Relief Vlv Control (scim)	169	0.0	0.0	0.0	6 max

* Limits Not Specified

4.4.1.1 (Continued)

Pneumatic Control System Decay Checks

Function	Measurement Initial	Measurement Final	Limits
Reg Disch Press - Vlv Pos, Normal (psig)	527.0	524.0	*
Reg Disch Press - Vlv Pos, Activated (psig)	570.0	326.0	*

Engine Start Tank Leak Checks

Function	Measurement	Limits
Vent Control Solenoid Seat Leakage (scim)	0.0	10 max
Initial Fill, Check Vlv Reverse Lkg (scim)	0.0	2 max
Vent & Relief Valve Seat Leakage (scim)	0.0	2 max
Dump Valve Bellows Leakage (scim)	0.0	0
Bottle Decay (Delta M) (lb-mass/hr)	0.0037	0.0066 max

LH_2 Repressurization System Leak Checks

Function	Measurement	Limits
O_2H_2 Burner Control Vlv Seat Lkg (scim)	0.0	*
O_2H_2 Burner Control Vlv Pilot Bleed Lkg (scim)	0.0	*
O_2H_2 Burner Mod Cont Vlv Int Lkg (scim)	0.0	12 max
O_2H_2 Burner Cont Vlv & Check Vlv Rev Lkg (scim)	0.2	*
O_2H_2 Burner Check Vlv Reverse Lkg (scim)	0.2	5 max
O_2H_2 Burner Coil Leakage (scim)	0.0	0

LH_2 Pressurization System Leak Check

Function	Measurement	Limits
LH_2 Press Module Check Vlv Rev Lkg (scim)	0.0	10 max
LH_2 Prepress Check Vlv Rev Lkg (scim)	0.0	0

Thrust Chamber Checks

Function	Measurement	Limits
LOX Dome		
Purge Check Valve Reverse Lkg (scim)	0.0	4 max
Main Oxidizer Valve		
Idler Shaft Seal Leakage (scim)	0.0	10 max
Drive Shaft Seal Leakage (scim)	0.0	10 max
Main Fuel Valve		
Idler Shaft Seal Leakage (scim)	0.54	10 max
Drive Shaft Seal Leakage (scim)	0.0	10 max

* Limits Not Specified

4.4.1.1 (Continued)

Function	Measurement	Limits
Thrust Chamber		
Pressure (psig)	26.0	20 min
Jacket Purge Check Vlv Rev Lkg (scim)	0.38	25 max

LOX Pressurization & Repressurization System Leak Checks

Function	Measurement	Limits
Cold Helium Sphere		
Fill Check Vlv Rev Lkg (scim)	0.0	0
Shutoff Vlv Seat & Pilot Bleed Lkg (scim)	0.0	12.5 max
LOX Press Module Internal		
Hot Gas Bypass Vlv Seat & Pilot Bleed Lkg (scim)	0.0	1000 max
O_2H_2 Burner LOX Repress System		
Burner Control Valve Seal Leakage (scim)	0.0	*
Burner Control Valve Pilot Bleed Lkg (scim)	0.0	*
Burner Module Control Vlv Internal Lkg (scim)	0.0	12 max
System Check Valve Reverse Leakage (scim)	0.0	5 max
Combined Burner Check Vlv & Cont Vlv Seat Leakage (scim)	0.0	0
Burner Check Vlv Rev Leakage (scim)	0.0	0
Burner Coil Leakage (scim)	0.0	0
Cold Helium System		
LOX Tank Prepress Check Vlv Rev Lkg (scim)	0.0	0

LOX Tank O_2H_2 Burner & Engine Feed System Leak Checks

Function	Measurement	Limits
LOX Tank Helium Content		
Top (%)	99.77	75 min
Bottom (%)	99.52	75 min
Engine Feed Sys Internal Leak Checks		
LOX Prevlv & Chilldown Shutoff Vlv Seat & Chilldown Return Check Vlv Lkg (scim)	2800.0	*
LOX Chilldown Ret Check Vlv Rev Lkg (scim)	3.8	350 max
LOX Prevlv & Chilldown Shutoff Vlv Combined Seat Leakage (scim)	11.2	150 max
LOX Bleed Vlv & Chilldown Return Check Vlv Rev Leakage (scim)	4.2	*
LOX Bleed Vlv Seat Leakage (scim)	0.4	300 max
Main Oxidizer Vlv Seat Leakage (scim)	0.0	10 max
LOX Tank & Engine Feed System Leak Checks		
Oxidizer Pump Speed Pickup Seat Bleed (scim)	0.0	0

* Limits Not Specified

4.4.1.1 (Continued)

Function	Measurement	Limits
LOX Turbopump Torque Checks		
Pump Primary Seal Leakage:		
Max (scim)	7.0	350 max
Min (scim)	39.0	350 max
Turbine Torque:		
Breakaway (in/lbs)	41.0	1000 max
Running (in/lbs)	41.0	200 max
LOX Chilldown Pump Purge Flow Checks		
Pump Purge Shutoff Sol Vlv Leakage (scim)	0.0	0 max
Pump Shaft Seal Leakage (scim) (Tank Pressurized & Purge On)	3.8	*
Pump Shaft Seal Lkg - Pump Direction (scim)	0.0	75 max
Pump Shaft Seal Lkg - Tank Direction (scim)	3.8	25 max
LOX Valves Checks		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0.2	10 max
Closed Position (scim)	0.0	10 max
Internal Closed Pos (scim)	0.0	75 max
F&D Vlv Seat Leakage (scim)	0.0	100 max
F&D Vlv Primary Shaft Seal Lkg (scim)	0.0	31 max
O_2H_2 Burner LOX		
Burner LOX Prop Valve Seat Lkg (scim)	0.0	0.7 max
Burner LOX Shutdown Vlv Seat Lkg (scim)	0.0	*

LH_2 Tank, O_2H_2 Burner & Engine Feed System Leak Checks

Function	Measurement	Limits
LH_2 Tank Helium Content		
Top (%)	99.56	75 min
Bottom (%)	95.65	75 min
Engine Feed System Internal Leak Checks		
LH_2 Prevlv & Chilldown Shutoff Vlv & C/D Return Check Vlv Rev Lkg (scim)	9.0	*
LH_2 C/D Ret Check Vlv Rev Lkg (scim)	2.2	350 max
LH_2 Prevlv & C/D Shutoff Vlv Combined Seal Leakage (scim)	6.8	150 max
LH_2 Bleed Vlv & C/D Return Check Vlv Rev Leakage (scim)	1.5	*
LH_2 Bleed Vlv Seat Leakage (scim)	0.7	300 max
MOV & MFV Combined Seat Leakage (scim)	0.0	*
Main Fuel Vlv Seat Leakage (scim)	0.0	10 max

* Limits Not Specified

4.4.1.1 (Continued)

Function	Measurement	Limits
Engine Purge System Leak Checks		
LH_2 Pump Drain Check Vlv Rev Lkg (scim)	0.0	25 max
LH_2 Pump Drain Check Vlv Fwd Flow 30 psi (scim)	0.0	30 max
LH_2 Pump Drain Check Vlv Fwd Flow 60 psi (scim)	6000.0	2420 min
LH_2 Pump Purge Check Vlv Rev Lkg (scim)	0.0	25 min
LH_2 Pump Intermediate Seal Lkg (scim)	15.0	500 max
LH_2 Turbine Seal Cavity Prg Check Vlv Rev Leakage (scim)	0.0	25 max
LOX Turbine Seal Cavity Prg Check Vlv Rev Leakage (scim)	0.0	25 max
LH_2 Tank & Engine Feed System Leak Checks		
LH_2 Low Pressure Duct Pressure (psig)	28.0	30 max
LH_2 Pump Speed Monitor Seal Bleed (scim)	0.0	0
LH_2 Turbopump Torque Checks		
LH_2 Pump Primary Seal Leakage:		
Max (scim)	9.0	350 max
Min (scim)	7.0	350 max
Turbine Torque:		
Breakaway (in/lbs)	25.0	1000 max
Running (in/lbs)	20.0	300 max
LH_2 Valves Leak Checks		
Prevalve Shaft Seal Leakage:		
Open Position (scim)	0.0	10 max
Closed Position (scim)	0.0	10 max
Fill & Drain Valve Seat Leakage (scim)	0.0	100 max
LH_2 Fill & Drain Vlv Primary Shaft Seal Leakage (scim)	0.0	31 max
O_2H_2 Burner LH_2 System Leak Check		
Combined Burner LH_2 Prop Vlv & LOX S/D Vlv Seat Leakage (scim)	0.0	*
Burner LH_2 Prop Valve Seat Leakage (scim)	0.0	0.7 max

Engine GG and Exhaust System Leak and Flow Test

Function	Measurement	Limits
GG Fuel Purge Ck Vlv Rev Lkg (scim)	0.0	25 max
LH_2 Turbine Seal Leakage (scim)	4000	3000 scim Above 2nd E&M Leakage Value - max

* Limits Not Specified

4.4.1.1 (Continued)

Function	Measurement	Limits
2nd E&M Value	1400	*
LOX Turbine Seal Leakage (scim)	11.5	350 max
STDV Gate Seal Leakage (scim)	10.5	20 max
OTBV Shaft Seal Leakage (scim)	14	15 max
Oxid Manifold Carrier Flange (scim)	0.44	20 max
Hydraulic Pump Shaft Seal Lkg (scim)	0.40	228 max
GG LOX Prop Vlv Seat Lkg (scim)	0.0	20 max
Combined GG LOX & LH_2 Prop Vlv Seat & Pump Shaft Seal Lkg (scim)	0.0	*
GG LH_2 Prop Vlv Seat Lkg & Fuel Pump Omni Seal Lkg (scim)	0.0	15 max

Engine Pump Purge Leak Checks

Function	Measurement	Limits
Pump Purge Module Internal Leak Checks		
Purge Valve Seat Leakage (scim)	0.0	12 max
Purge Discharge Pressure (psig)	93.0	67 to 110
Pump Purge Flow Checks		
GG Fuel Purge Flow (scim)	3500.0	2400 min
LOX Turbine Seal Purge Flow (scim)	3500.0	2400 min
LH_2 Turbine Seal Purge Flow (scim)	3700.0	2400 min
Fuel Pump Seal Cavity Purge Flow (scim)	1250.0	200 min

Engine Pneumatics Leak Checks

Function	Measurement	Limits
Helium Control Solenoid Energized Leak Checks		
Low Press Relief Vlv Seal Lkg (scim)	0.2	5 max
Low Press Relief Vlv Pilot Bleed Lkg (scim)	0.0	10 max
Fast Shutdown Vent Port Diaph Lkg (scim)	0.0	3 max
Press Act Purge Vlv Diaph Lkg (scim)	0.0	3 max
Int Pneu Sys Lkg (He Cont Sol On) (scim)	5.0	20 max
LOX Pump Intermediate Seal Purge Leak Checks		
Seal Leakage Pump Direction (scim)	0.0	*
Seal Leakage Turbine Direction (scim)	80.0	*
Seal Leakage Total (scim)	80.0	850 max
Seal Purge Check Vlv Overboard Flow (scim)	2100.0	*
Seal Purge Flow (scim)	2180.0	1300 to 3500
Ignition Phase Solenoid Energized Leak Checks		
Start Tnk Disch Vlv 4-Way Sol Seat Lkg (scim)	3.5	15 max
Internal Pneu Sys Lkg (Ign Phase Sol On) (scim)	5.0	20 max

* Limits Not Specified

4.4.1.1 (Continued)

Function	Measurement	Limits
Start Tank Discharge Valve Solenoid Energized Leak Checks		
STDV 4-Way Sol Seat Lkg (Energized) (scim)	12.0	15 max
Mainstage Control Solenoid Energized Leak Check		
Press Act Fast Shutdown Vlv Seat Lkg (scim)	0.0	10 max
Int Pneu Sys Lkg (Mnstg Sold On) (scim)	13.0	20 max
Pressure Actuated Purge System Leak Check		
Press Act Purge Vlv Vent Seat Lkg (scim)	0.0	10 max
Press Act Purge Vlv Inlet Seat Lkg (scim)	0.0	10 max
Engine Control Bottle Fill System Leak Check		
Eng Cont Bot Fill Check Vlv Rev Lkg (scim)	0.0	3 max
Eng Cont Bot Decay Check (Delta M) (lb-mass/hr)	0.0153	0.036 max

LOX & LH_2 Vent System Leak Checks

Function	Measurement	Limits
LOX Vent System Leak Checks		
Combined LOX Vent & Relief Vlv & NPV Seat & Pilot Bleed Lkg (scim)	0.0	160 max
Combined LOX V&R Vlv & Relief Vlv Seat, Pilot Bleed Lkg (scim)	45.0	*
LOX Vent Boost Piston Seal Lkg (scim)	45.0	1728 max
LOX Vent Valve Open Act Seal Lkg (scim)	0.0	75 max
LOX NPV Vlv Open Act Piston Seal Lkg (scim)	0.0	150 max
Propulsive Vent System Leak Checks		
Cont Vent & Orifice Bypass Vlv Seat Lkg (scim)	0.0	16 max
Nonpropulsive Vent System Leak Checks		
Bidirect Vent Vlv Act Seal & Blade Shaft Seal Lkg - Flight Pos (scim)	0.0	3.5 max
Bidirect Vent Vlv Seat Lkg (Flt Pos) (scim)	0.0	50 max
Bidirect Vent Vlv Act Seal & Blade Shaft Seal Leakage - Ground Pos (scim)	0.0	3.5 max
Ground Vent System Leak Checks		
Combined LH_2 V&R Vlv, Relief Vlv Seat, & Pilot Bleed Lkg (scim)	0.0	210 max
Combined LH_2 V&R Vlv & Relief Vlv Seat, Pilot Bleed, & Boost Piston Seal Lkg (scim)	0.0	*
LH_2 V&R Vlv Boost Piston Seal Lkg (scim)	0.0	1728 max
LH_2 Vent Vlv Open Act Seal Lkg (scim)	0.0	75 max
Bidirect Vent Vlv Seat Lkg (Gnd Pos) (scim)	0.0	50 max
Bidirect Vent Vlv Act Piston Leakage:		
Ground Position (scim)	0.0	3 max
Flight Position (scim)	0.0	3 max
LH_2 Latching Relief Vlv Open Act Piston Seal Lkg (scim)	0.0	150 max

* Limits Not Specified

4.4.2 Forward Skirt Thermoconditioning System Checkout Procedure (1B41955 C)

The forward skirt thermoconditioning system (TCS), P/N 1B38426-513, was functionally checked per this manual procedure to prepare it for operation and to verify that the system was capable of supporting the stage poststorage checkout operations. The checkout utilized the TCS servicer, P/N 1A78829-1, which conditioned and supplied the water/methanol heat transfer fluid to the TCS.

Checkout of the TCS was accomplished from 26 October through 11 November 1968, and was certified as acceptable on 12 November 1968. Preliminary operations included setup and connection of the servicer to the TCS and inspection of the TCS panels for open equipment mounting bolt holes and properly torqued bolts. The TCS was pressurized to 32 ± 1 psig with freon gas and was then leak checked with the gaseous leak detector, P/N 1B37134-1. The areas checked for leakage included all TCS B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold bellows.

The TCS was purged with gaseous nitrogen; then, water/methanol fluid was circulated through the system. Water/methanol samples were taken from the fluid sample pressure valve (system inlet) and the fluid sample return valve (system outlet) and checked for cleanliness, specific gravity, and temperature. Particle counts for each micron range were well within the acceptable cleanliness limits specified. The system inlet sample had one particle in the 175-700 micron range (25 allowed) and no particles in either the 700-2500 micron range or above 2500 microns (non allowed). The system return sample had no particles

4.4.2 (Continued)

in the 175-700 micron range and none in the other micron ranges. The specific gravity and temperature of the fluid were measured with a hydrometer and thermometer, respectively, determining that the water/methanol concentration was within the acceptable mixture range.

A differential pressure test was conducted to verify correct system geometry and proper flow distribution. The test was conducted by measuring the differential pressure between the TCS inlet and outlet, as well as the inlet and outlet temperatures, while maintaining a water/methanol flow rate of 7.8 $\pm$0.2 gpm. The differential pressure was recorded as 16.9 psid, while inlet and outlet temperatures were both 59°F.

Two leakage conditions were noted during the procedure; both were associated with the thermoconditioning servicer unit. FARR 500-607-408 reported that the pneumatic pressure regulator was leaking through, and FARR 500-607-394 stated that the system shutoff valve was leaking. The discrepant parts were removed and replaced.

Two revisions were made during the procedure to authorize special tests to verify leakage of the pneumatic purge pressure regulator and the system supply shutoff valve.

4.4.3 Stage and GSE Manual Controls Check (1B70177 G)

This postmodification procedure verified manual control capability for the pneumatic regulators and valves in the propulsion GSE and stage systems. The test consisted of supplying electrical and pneumatic signals to the system components and checking for the proper response utilizing the Beta I Test Control Center (TCC) panels.

The manual controls checkout was satisfactorily conducted on 10 October 1968, and was certified as acceptable on 13 November 1968. Preliminary GSE setup operations were initiated to verify that the switches and valves on the test consoles were positioned properly for the functional check. The GSE manual controls were then operated to ensure their functional capability.

The stage control helium system check began by verifying that the LOX repressurization spheres were isolated per H&CO 1B70422 and that the stage purge hand valves were closed. The control helium spheres were pressurized to 100 ± 25 psig and the control sphere dump valves were functioned; then, the spheres were pressurized to 500 ± 50 psig for the stage valves control check.

The stage valves control check was accomplished by supplying signals manually from the Beta I TCC control panels to the stage valve controls in a specified sequence and then verifying correct talkback. In addition, test stand personnel verified stage valve actuation audibly or by touch. Starting at the TCC main-stage propulsion manual control panel, the LH_2 and LOX chilldown shutoff valves and the LH_2 and LOX prevalves were individually cycled and verified. At the TCC LH_2 control panel, the LH_2 tank vent and the fill and drain valves were

4.4.3 (Continued)

cycled open and closed. The LH_2 tank vent boost close valve and the LH_2 fill and drain boost close valve were cycled. The LH_2 directional vent valve was cycled from the flight to the ground position. Using the TCC LOX control panel, the LOX tank vent and fill and drain valves were cycled open and closed. The LOX tank vent boost close valve and the LOX fill and drain boost close valve were cycled. The cold helium shutoff valve was cycled open and closed. The valves cycled from the TCC stage supply panel included the engine control bottle dump valve, the cold helium bottle dump valve, the start tank dump valve, and the LOX and LH_2 repressurization dump valves. The control helium bottle fill valve was then closed.

The stage valves control check was completed at the TCC repressurization control panel by cycling the O_2H_2 burner LOX and LH_2 propulsion valves and the LOX shutdown valve.

The final portion of the procedure consisted of the LH_2 and LOX umbilical purge interlock check using the TCC LH_2 and LOX control panels.

The test was terminated by securing the test stand pneumatic systems using the Beta III TCC control panels and the test stand pneumatics consoles.

There were no FARR's resulting from this checkout.

Six revisions were recorded in the procedure during checkout as follows:

a. Four revisions deleted portions of the procedure that were not required for this checkout.

4.4.3 (Continued)

b. One revision lowered the nitrogen supply pressure requirement for console "B" from 2000 psi to 1800 psi. The later pressure was deemed sufficient to maintain 1500 psi to the first stage.

c. One revision authorized audible verification of the cold helium shutoff valve actuation as the panel talkback indication was not used.

4.4.4 Umbilical Interface Compatibility Check (1B64316 E)

Prior to connecting the forward and aft umbilical cables for automatic power on checks, this manual checkout provided the test sequences which were used to check the design specifications and the continuity of the stage umbilical wiring. Accomplished by point-to-point resistance checks of all umbilical circuits, this test ensured that the proper loads were present on all power buses and that the control circuits for the propulsion valves and safety items were within the prescribed tolerances.

This checkout was initiated on 29 October 1968, and was accepted as complete on 30 October 1968. A series of resistance measurements were made at specified test points on the signal distribution unit, P/N 1A59949-1, using 463A1A5J43-FF as the common test point for all measurements. These measurements verified that all wires and connections in the umbilical system were intact and of the proper material and wire gauge and that all resistance values and loads were within the design requirement limits. A Simpson, Model 260, multimeter and a Triplett, Model 630, multimeter were utilized to make the resistance meausrements. The particular test points, circuit functions, measured resistances, and resistance limits are listed in Test Data Table 4.4.4.1.

No FARR's or revisions were written against this test.

4.4.4.1 Test Data Table, Umbilical Interface Compatibility Check

Reference Designation 463A2

Test Point	Function	Meas. Ohms	Limit Ohms
A2J29-C	Cmd., Ambient Helium Sphere Dump	23	10-60
CB-8-2	Cmd., Engine Ignition Bus Power Off	Inf.	Inf.
CB-9-2	Cmd., Engine Ignition Bus Power On	15	5-100

4.4.4.1 (Continued)

Test Point	Function	Meas. Ohms	Limit Ohms
CB-10-2	Cmd., Engine Control Bus Power Off	Inf.	Inf.
CB-11-12	Cmd., Engine Control Bus Power On	6.2	5-100
A2J29-N	Cmd., Engine He Emerg Vent Control On	48	10-60
A2J29-P	Cmd., Fuel Tank He Sphere Dump	32	10-60
A2J29-Y	Cmd., Start Tank Vent Pilot Vlv Open	49	10-60
CB-4-2	Amd., LOX Tank Cold He Sphere Dump	29	10-60
A2J29-c	Cmd., LOX Tank Repress He Sphere Dump	32	10-60
A2J29-h	Cmd., Fuel Tank Vent Pilot Vlv Open	53	10-300
	(Same, reverse polarity)	Inf.	500k min
A2J29-i	Cmd., Fuel Tank Vent Vlv Boost Close	56	10-80
	(Same, reverse polarity)	Inf.	500k min
A2J29-q	Cmd., Amb He Supply Shutoff Vlv Close	19	10-60
A2J30-H	Cmd., Cold He Supply Shutoff Vlv Close	1.25	1.5k max
	(Same, reverse polarity)	Inf.	Inf.
A2J30-W	Cmd., LOX Vent Valve Open	63	10-300
	(Same, reverse polarity)	Inf.	500k min
A2J30-X	Cmd, LOX Vent Valve Close	65	10-80
	(Same, reverse polarity)	Inf.	500k min
A2J30-Y	Cmd., LOX & Fuel Prevlv Emerg Close	65	10-80
	(Same, reverse polarity)	Inf.	Inf.
A2J30-Z	Cmd., LOX & Fuel C/D Vlve Close	80	10-80
	(Same, reverse polarity)	Inf.	500k min
A2J30-b	Cmd., LOX F&D Valve Boost Close	31	10-40
A2J30-c	Cmd., LOX F&D Drain Valve Open	34	10-40
A2J30-d	Cmd., Fuel F&D Valve Boost Close	29	10-40
A2J30-e	Cmd., Fuel F&D Valve Open	29	10-40
A2J42-F	Meas., Bus +4D111 Regulation	160	100 min
A2J36-y	Meas., Bus +4D141 Regulation	850	50 min
A2J6-AA	Sup., 28v Bus +4D119 Talkback Power	90	60 -120

Reference Designation 463A1

Test Point	Function	Meas. Ohms	Limit Ohms
A5J41-A	Meas., Bus +4D131 Regulation	120	20 min
A5J41-E	Meas., Bus +4D121 Regulation	2.25k	1.6k min
A5J53-AA	Sup., 28v +4D119 Fwd Talkback Power	75	60-100

4.4.5 Auxiliary Propulsion System Interface Compatibility Checkout (1B49558 B)

Contained in this manual checkout were the test sequences necessary to verify a suitable electrical interface between the stage and the auxiliary propulsion system (APS) modules, P/N 1A83918-519, S/N's 1010-1 and 1010-2, after installation of the modules on the stage.

This checkout was satisfactorily performed and certified as acceptable on 29 October 1968. Preliminary inspection of plugs and sockets was accomplished prior to mating to ensure against damaged electrical connectors. Resistance checks verified proper connections between the stage control relay packages and the APS engine valves, and also between the stage aft skirt and the APS control system components. Refer to Test Data Table 4.4.5.1 for results of the point-to-point resistance measurements.

There were no discrepancies recorded by FARR's as a result of this checkout.

One revision was written to delete all sections of the procedure applicable to testing with APS modules because the APS simulators had been installed for poststorage checkout, as required.

4.4.5.1 Test Data Table, APS Interface Compatibility

Common Test Point: Stage Ground

Stage Comp.	Test Point	APS Component	Meas. Ohms	Limit Ohms
404A51A4	J4 A	414A8L1 Eng. 1, Valve A	28	25 ± 5
404A51A4	J4 B	414A8L5 Eng. 1, Valve 1	28	25 ± 5
404A51A4	J4 C	414A8L2 Eng. 1, Valve C	28	25 ± 5
404A51A4	J4 D	414A8L6 Eng. 1, Valve 3	28	25 ± 5
404A51A4	J4 E	414A8L3 Eng. 1, Valve B	28	25 ± 5
404A51A4	J4 F	414A8L7 Eng. 1, Valve 2	28	25 ± 5

4.4.5.1 (Continued)

Stage Comp.	Test Point	APS Component	Meas. Ohms	Limit Ohms
404A51A4	J4 G	414A8L4 Eng. 1, Valve D	28	25 ± 5
404A51A4	J4 H	414A8L8 Eng. 1, Valve 4	28	25 ∓ 5
404A51A4	J4 J	414A10L1 Eng. 3, Valve A	28	25 ± 5
404A51A4	J4 K	414A10L5 Eng. 3, Valve 1	28	25 ± 5
404A51A4	J4 L	414A10L2 Eng. 3, Valve C	28	25 ± 5
404A51A4	J4 M	414A10L6 Eng. 3, Valve 3	28	25 ± 5
404A51A4	J4 N	414A10L3 Eng. 3, Valve B	28	25 ± 5
404A51A4	J4 P	414A10L7 Eng. 3, Valve 2	28	25 ± 5
404A51A4	J4 R	414A10L4 Eng. 3, Valve D	28	25 ± 5
404A51A4	J4 S	414A10L8 Eng. 3, Valve 4	28	25 ± 5
404A51A4	J4 T	414A9L1 Eng. 2, Valve A	28	25 ± 5
404A51A4	J4 U	414A9L5 Eng. 2, Valve 1	28	25 ± 5
404A51A4	J4 V	414A9L2 Eng. 2, Valve C	28	25 ± 5
404A51A4	J4 W	414A9L6 Eng. 2, Valve 3	28	25 ± 5
404A51A4	J4 X	414A9L3 Eng. 2, Valve B	28	25 ± 5
404A51A4	J4 Y	414A9L7 Eng. 2, Valve 2	28	25 ± 5
404A51A4	J4 Z	414A9L4 Eng. 2, Valve D	28	25 ± 5
404A51A4	J4 a	414A9L8 Eng. 2, Valve 4	28	25 ± 5
404A71A19	J4 A	415A8L1 Eng. 1, Valve A	28	25 ± 5
404A71A19	J4 B	415A8L5 Eng. 1, Valve 1	28	25 ± 5
404A71A19	J4 C	415A8L2 Eng. 1, Valve C	28	25 ± 5
404A71A19	J4 D	415A8L6 Eng. 1, Valve 3	30	25 ± 5
404A71A19	J4 E	415A8L3 Eng. 1, Valve D	30	25 ± 5
404A71A19	J4 F	415A8L7 Eng. 1, Valve 2	28	25 ± 5
404A71A19	J4 G	415A8L4 Eng. 1, Valve D	28	25 ± 5
404A71A19	J4 H	415A8L8 Eng. 1, Valve 4	28	25 ± 5
404A71A19	J4 J	414A10L1 Eng. 3, Valve A	30	25 ± 5
404A71A19	J4 K	414A10L5 Eng. 3, Valve 1	30	25 ± 5
404A71A19	J4 L	414A10L2 Eng. 3, Valve C	30	25 ± 5
404A71A19	J4 M	414A10L6 Eng. 3, Valve 3	30	25 ± 5
404A71A19	J4 N	414A10L3 Eng. 3, Valve B	30	25 ± 5
404A71A19	J4 P	414A10L7 Eng. 3, Valve 2	30	25 ± 5
404A71A19	J4 R	414A10L4 Eng. 3, Valve D	30	25 ± 5
404A71A19	J4 S	414A10L8 Eng. 3, Valve 4	30	25 ± 5
404A71A19	J4 T	415A9L1 Eng. 2, Valve A	30	25 ± 5
404A71A19	J4 U	415A9L5 Eng. 2, Valve 1	30	25 ± 5
404A71A19	J4 V	415A9L2 Eng. 2, Valve C	30	25 ± 5
404A71A19	J4 W	415A9L6 Eng. 2, Valve 3	30	25 ± 5
404A71A19	J4 X	415A9L3 Eng. 2, Valve B	30	25 ± 5
404A71A19	J4 Y	415A9L7 Eng. 2, Valve 2	30	25 ± 5
404A71A19	J4 Z	415A9L4 Eng. 2, Valve D	30	25 ± 5
404A71A19	J4 a	415A9L8 Eng. 2, Valve 4	30	25 ± 5

4.4.5.1 (Continued)

Stage Comp.	Test Point	APS Component	Meas. Ohms	Limit Ohms
404A4	J7 r	414A5L1	600	550 to 650
404A4	J7 d	414A5L1	600	550 to 650
404A4	J7 p	414A6L1	600	550 to 650
404A4	J7 x	414A1L1	600	550 to 650
404A4	J7 f	414A1L1	600	550 to 650
404A4	J7 v	414A2L2	600	550 to 650
404A4	J7 m	414A6L2	600	550 to 650
404A4	J7 t	414A2L2	600	550 to 650
404A4	J7 z	SPARE	Inf.	10 meg (min)
404A4	J7 g	415A5L1	600	550 to 650
404A4	J7 c	415A5L1	600	550 to 650
404A4	J7 n	415A6L1	600	550 to 650
404A4	J7 w	415A1L1	600	550 to 650
404A4	J7 e	415A1L1	600	550 to 650
404A4	J7 u	415A2L1	600	550 to 650
404A4	J7 k	415A6L2	600	550 to 650
404A4	J7 s	415A2L2	600	550 to 650
404A4	J7 y	SPARE	Inf.	10 meg (min)
404A2A16	J2 B	414A7L1 Eng. 4, Valve A	600	550 to 650
404A2A16	J2 C	414A7L2 Eng. 4, Valve 1	600	550 to 650
404A2A16	J2 A	414A7L1 Eng. 4, Valve A	600	550 to 650
404A2A16	J2 D	414A7L2 Eng. 4, alve 1	600	550 to 650

4.4.6 Stage Power Setup (1B55813 K)

Prior to the initiation of postmodification checkouts for the stage on Test Stand Beta III, the automatic stage power setup procedure verified the capability of the GSE automatic checkout system (ACS) to control power switching to and within the stage and ensured that the stage power distribution system was not subjected to excessive static loads during initial setup sequences. After successful demonstration, this procedure was used to establish initial conditions during the subsequent postmodification automatic checkouts.

Initial test attempts one and two, conducted on 29 October 1968, were aborted due to switch selector malfunction caused by incorrect stage wiring. After correction, test attempt three was conducted on 29 October 1968, and also aborted due to operator error. The DDAS source selector switch had been incorrectly set. Test attempt four, conducted on 30 October 1968, was a successful demonstration of stage power setup, with the exception of certain valve closed indications described later in this narrative report. The proper closed stage for these valves was demonstrated during subsequent tests per this procedure on 4 November 1968, and 12 November 1968. Measurements listed in Test Data Table 4.4.6.1 are taken from the test of 30 October 1968.

The test was started by resetting all matrix magnetic latching relays and verifying that the corresponding command relays were in the proper state. The umbilical connectors were verified to be mated, and the LOX and LH_2 inverters were verified to be disconnected. The bus 4D119 talkback power was turned on, and the prelaunch checkout group was turned off. The forward and aft power buses were transferred to external power. The sequencer power, engine control bus power, engine

4.4.6 (Continued)

ignition bus power, APS bus 1 and bus power, and propellant level sensor power were all verified to be off. The power to the range safety receivers and EBW firing units was transferred to external and verified to be off. The switch selector checkout indication enable and the flight measurement indication enable were both turned on. The bus 4D131 28 vdc power supply was turned on, and the forward bus 1 initial current and voltage were measured.

The range safety system safe and arm device was verified to be in the SAFE condition. The 70 pound ullage engine relay, the LH_2 continuous vent valve relays, the LH_2 and LOX repressurization mode relay, the O_2H_2 burner propellant valve relay, and the engine passivation relays were all verified to be reset. The LH_2 continuous vent and relief overboard valve was verified to be closed, and the LOX repressurization control valve enable was verified to be on. Power was verified to be off for the propellant utilization boiloff bias. The O_2H_2 burner spark systems 1 and 2 voltages were measured and recorded. The O_2H_2 LOX and LH_2 valves were verified to be closed.

The LH_2 continuous vent orificed bypass valve was indicated as not closed, a malfunction indication that occurred because the electrical cables were not installed. The same was true for closed indication malfunctions for the LH_2 vent valve, the LH_2 fill and drain valve, and the LH_2 latch relief valve because cabling was disconnected during various stages of valve rework, replacement, and preshipment modification. The proper closed indication for these valves was verified after completion of the rework and modification during stage power setup on 4 November 1968, and initial conditions scan on 12 November 1968.

4.4.6 (Continued)

The forward bus 1 quiescent current was measured. The PCM system group power was turned on, and the current was measured and recorded. The forward bus 2 28 vdc power supply was turned on, and the forward bus 2 current and voltage were measured.

The DDAS ground station source select switch was manually set to position 1, and the ground station was verified to be in synchronization. The cold helium supply shutoff valve was closed. The aft bus 1, 28 vdc power supply was turned on, and the aft bus 1 power supply current and voltage were measured. The sequencer power was turned on and the current was measured. The forward and aft battery load test off commands were set.

A series of checks during initial conditions scan on 12 November 1968, verified that the stage functions were in the proper state. Fifty-five functions were verified to be off and twenty-eight were verified to be on. The LOX and LH_2 prevalves and chilldown shutoff valves were verified as open, and the LOX and LH_2 vent valves and fill and drain valves were verified as closed.

The final operations of this automatic procedure measured the forward and aft 5 volt excitation modules, the range safety EBW firing unit charging voltages, the aft bus 2 voltage, the forward and aft battery simulator voltages, and the component test power voltage.

No FARR's were initiated as a result of stage power setup testing. However, six revisions were recorded in the procedure as follows:

a. Three revisions authorized the second, third, and fourth test attempts on 29 and 30 October 1968, as previously described in this narrative.

4.4.6 (Continued)

b. One revision corrected a program error.

c. Two revisions discussed the malfunctions indicating failure to achieve valve closure for certain valves disconnected electrically due to various stages of rework and modification, as previously described in this narrative. Reference was made to stage power setup conducted as "Run 8, Issue 2" on 4 November 1968, which was the first demonstration of proper valve closure indications after the rework, replacement, and modification had been completed, permitting the valve electrical connections to be made.

4.4.6.1 Test Data Table, Stage Power Setup

Function	Measured Value	Limit
Forward Bus 1 Power Supply Current (amps)	2.699	39 max
Forward Bus 1 Voltage (vdc)	28.199	28 ± 0.5
O_2H_2 Burner Spark System 1 Voltage (vdc)	0.020	0 ± 0.5
O_2H_2 Burner Spark System 2 Voltage (vdc)	0.000	0 ± 0.5
Forward Bus 1 Quiescent Current (amps)	2.800	8 max
PCM System Group Current (amps)	8.399	7 ± 3
Forward Bus 2 Power Supply Current (amps)	0.600	2 max
Forward Bus 2 Voltage (vdc)	28.278	28 ± 0.5
Aft Bus 1 Power Supply Current (amps)	0.600	2 max
Aft Bus 1 Voltage (vdc)	28.118	28 ± 0.5
Sequencer Power (amps)	0.100	0 ± 3
Aft 5v Excitation Module Voltage (vdc)	5.001	5 ± 0.030
Fwd 1 5v Excitation Module Voltage (vdc)	5.004	5 ± 0.030
Fwd 2 5v Excitation Module Voltage (vdc)	4.995	5 ± 0.030
RS 1 EBW Firing Unit Chg Voltage (vdc)	0.005	0 ± 1
RS 2 EBW Firing Unit Chg Voltage (vdc)	0.010	0 ± 1
Aft Bus 2 Voltage (vdc)	0.079	0 ± 1
Forward Battery 1 Simulator Voltage (vdc)	0.039	0 ± 1
Forward Battery 2 Simulator Voltage (vdc)	0.000	0 ± 1
Aft Battery 1 Simulator Voltage (vdc)	0.039	0 ± 1
Aft Battery 2 Simulator Voltage (vdc)	0.079	0 ± 1
Component Test Power Voltage (vdc)	0.680	0 ± 1

4.4.7 Stage Power Turnoff (1B55814 J)

The stage power turnoff procedure was used for automatic shutdown of the stage power distribution system, returning the stage to the de-energized condition after completion of the various system checkout procedures during postmodification testing of the stage on Test Stand Beta III. The procedure deactivated the stage relays so that no current flowed from the battery simulators through the stage wiring. All internal/external transfer relays were set to the external condition.

Satisfactory demonstration of this procedure was accomplished on 29 October 1968. Stage power turnoff measurement values for this demonstration issue are tabulated in Test Data Table 4.4.7.1. Following this acceptance, the stage power turnoff procedure was used to shut down the stage at the conclusion of the various automatic checkouts conducted during postmodification operations.

The automatic stage power turnoff started with verification that the umbilical connectors were mated and that the flight measurement indication enable was turned on. The bus 4D119 talkback power, the forward bus 1 and aft bus 1, 28 vdc power supplies, and the sequencer power were all verified to be on. The forward bus 1 and aft bus 1 voltages were then measured.

The switch selector functions were then turned off; the O_2H_2 burner spark systems 1 and 2 voltages were measured; and a series of checks verified that the stage electrical functions were in the proper stage of off, reset, or closed, with the exception of malfunction indications described in detail in the revision discussion of this narrative report.

4.4.7 (Continued)

The forward and aft bus power supplies were verified to be off, and the forward and aft bus battery simulator voltages were measured. The stage buses were then transferred to external power, and the forward and aft stage bus voltages were measured. The EBW pulse sensor power was turned off, and the range safety receivers and the EBW firing units were transferred to external power. The range safety system safe and arm device was verified to be on safe, and the bus 4D119 talkback power was turned off. The matrix magnetic latching relays were then reset, thus completing this demonstration run for stage power turnoff.

There were no FARR's written against this test. However, three revisions were recorded in the procedure as follows:

a. Two revisions noted malfunction indications that occurred because certain valves were not installed at the time of the test. Verification of valve function for the O_2H_2 burner LOX propellant valve, LH_2 continuous vent orificed bypass valve, and the LH_2 latch relief valve was authorized to be performed after valve installation during the propulsion system test, H&CO 1B62753.

b. One revision recorded that a malfunction indication of failure to reset the engine passivation relays occurred because of disconnection of electrical cabling to correct improper stage wiring. Verification of correct talkback was authorized to be performed after electrical correction during the propulsion system test, H&CO 1B62753.

4.4.7.1 Test Data Table, Stage Power Turnoff

Function	Measured Value	Limits
Forward Bus 1 Voltage, Power On (vdc)	28.278	28 ± 2
Aft Bus 1 Voltage, Power On (vdc)	28.158	28 ± 2
O_2H_2 Burner Spark System 1 Voltage (vdc)	0.000	0 ± 0.5
O_2H_2 Burner Spark System 2 Voltage (vdc)	0.000	0 ± 0.5
Forward Bus 1 Battery Simulator Voltage (vdc)	0.000	0 ± 1
Forward Bus 2 Battery Simulator Voltage (vdc)	0.000	0 ± 1
Aft Bus 1 Battery Simulator Voltage (vdc)	0.000	0 ± 1
Aft Bus 2 Battery Simulator Voltage (vdc)	0.000	0 ± 1
Forward Bus 1 Voltage, Power Off (vdc)	0.079	0 ± 1.0
Forward Bus 2 Voltage, Power Off (vdc)	0.000	0 ± 1.0
Aft Bus 1 Voltage, Power Off (vdc)	0.039	0 ± 1.0
Aft Bus 2 Voltage, Power Off (vdc)	0.000	0 ± 1.0

4.4.8 Power Distribution System (1B55815 J)

The automatic checkout of the stage power distribution system during post-modification operation verified the capability of the GSE to control power switching to and within the stage and determined that initial static loads within the stage were not excessive. The procedure verified that particular stage relays were energized or de-energized, as required, and that bi-level talkback indications were received at the GSE. Static loading of the various stage systems was determined by measuring the GSE supply current before and after turn-on of each system.

The power distribution system test was initiated on 30 October 1968, and completed on 1 November 1968. The initial conditions scan was conducted per the stage power setup, H&CO 1B55813, and initial conditions were established for the test. Starting with engine control bus power turn-on, the current differential for the aft 1 power supply was measured. The engine control bus voltage M6 was measured and determined to be within tolerance. The APS bus power was turned on, and again the current differential for the aft 1 power supply was measured. This operation was repeated for the engine ignition bus by measuring aft 1 power supply current differential and engine control bus voltage M7. The engine ignition bus power and APS bus power were then turned off and verified.

The engine safety cutoff system (ESCS) power was turned on, and the aft 1 power supply current measured. The component test power was turned on, and the aft 1 power supply current differential and component test power voltage were measured. The component test power was turned off and verified to be off by measurement of the voltage. ESCS power was then turned off.

4.4.8 (Continued)

To check the emergency detection system (EDS), verification was made that the EDS 2 engine cutoff signal turned off the engine control bus power, prevented it from being turned back on, and also turned on the instrument unit (IU) range safety 1 EBW firing unit arm and engine cutoff signal. The engine control bus voltage was measured during this check and again after the check with the bus turned back on. Verification was made that the EBS 1 engine cutoff signal turned on the nonprogrammed engine cutoff signal and the AO multiplexer engine cutoff signal indication (K13). With the EDS 1 engine cutoff signal turned off, the engine ready bypass on turned off both the nonprogrammed engine cutoff signal and the AO multiplexer engine cutoff signal indications.

The propellant point level sensor test was started by turning on the propellant level sensor power and measuring the resulting current differential for the forward 1 power supply. Next, each of the four LH_2 tank and four LOX tank point level sensors was verified to respond to simulated wet condition on commands within the allowable 300 milliseconds tolerance. A series of checks verified that a dry condition indication from any two point level sensors in either tank, obtained by simulated wet condition off commands, resulted in the required engine cutoff signal. For the dry condition of LOX tank point level sensors 1 and 2, the LOX depletion engine cutoff timer value was measured to determine engine cutoff signal delay time. Each of the point level sensors was verified to respond to simulated wet condition off commands within the allowable 300 milliseconds tolerance. This completed the point level sensor testing.

4.4.8 (Continued)

Verification was made that the engine cutoff command turned on the AO multiplexer engine cutoff signal indication (K13), the engine cutoff indication (K140), and the engine cutoff, and that the nonprogrammed engine cutoff indication was not turned on as a result of the engine cutoff on command. With the engine cutoff command turned off, K140 was verified as off while K13 and the engine cutoff remained on until turned off by the engine ready bypass.

The propellant utilization (PU) inverter and electronics power supply current differentials were measured while power was momentarily turned on. The PCM RF assembly power was turned on, the RF group was verified to be on, the power supply differential current was measured, and the PCM RF transmitter output wattage was measured through the AO and BO multiplexers. With the telemetry RF silence command turned on, the RF group was verified to be off; the PCM RF transmitter output wattage was measured through the AO multiplexer; and the switch selector output monitor voltage (K128) was measured with the PCM RF assembly power and the switch selector read commands 1 and 2 turned on. With the telemetry RF silence command turned off, the RF group was verified to be on; and the PCM RF transmitter output wattage was again measured through the AO multiplexer.

The rate gyro voltages were manually verified to be 28.0 $\pm$2.0 vdc with gyro power turned on and 0.0 $\pm$2.0 vdc with gyro power turned off. The aft power supply was verified to be within the 56.0 $\pm$1.0 vdc tolerance. The bus 4D141, 56 volt supply was turned on, the voltage was measured, and the aft 2 power supply current was measured. The aft 2 power supply local sense indication was verified to

4.4.8 (Continued)

be off. The chilldown pump simulator was connected to the LOX and LH_2 chilldown inverters; and for each inverter measurements were made of the current draw, the phase voltages, and operating frequency. The inverter voltages and frequencies were monitored and measured through hardwire and telemetry.

A series of automatic checks verified the operation of the external/internal transfer system for forward buses 1 and 2 and aft buses 1 and 2. The battery simulator voltages and the electrical support equipment load bank voltages were measured initially; then, the power bus voltages were measured with the buses transferred to internal, and the bus local sense indications were verified to be off. The bus voltages were measured again with the buses transferred back to external, and the battery simulator voltages were measured with the simulators turned off. The aft bus 2 voltage was then measured with the bus power supply turned off.

A series of checks verified that the switch selector register was operating properly and that the instrument unit 28 vdc power supplies were on. Power was turned on to the range safety receivers after they were transferred to external power, and the resulting GSE power supply current differentials were measured. The range safety EBW firing units were verified to be on when they were transferred to external power and momentarily turned on. This completed the power distribution test.

There were no part shortages affecting the test and no problems resulting in the initiation of FARR's. Seven revisions were recorded in the procedure as follows:

4.4.8 (Continued)

a. One revision involved a malfunction indication that resulted from improper installation of electrical cabling. After correction, the program portions affected were repeated successfully without malfunction.

b. One revision attributed a malfunction of the aft bus 2 to a program error.

c. One revision explained that the talkback errors received were due to the LH_2 latch relief, the LH_2 fill and drain, the LH_2 vent, and the LH_2 continuous vent orifice bypass valves not being electrically connected.

d. One revision deleted the checkout of the RF assembly power, the FM/FM system power, and the preflight calibration. Checkout of these items was accomplished per 1B73601 NC.

e. One revision authorized the recording of several parameters during the procedure to demonstrate the elimination of noise after modifications to the stage instrumentation grounding system.

f. One revision attributed the "PCM system group current out-of-tolerance" malfunction to an increased current drain due to added parameters. An ALCO change was made, changing the tolerance from 5.0 ±3.0 amps to 8.5 ±3.0 amps. The program was successfully repeated.

g. One revision aborted the first run of stage power setup. The line printer paper was torn, and the test data was lost.

4.4.8.1 Test Data Table, Power Distribution System

Function	Measurement	Limits
Engine Control Bus Current (amps)	0.000	2 ± 2
Engine Control Bus Voltage (vdc)	27.999*	Bus 4D11 ± 1
APS Bus Current (amps)	0.550	1.5 ± 3
Engine Ignition Bus Current (amps)	0.200	0 ± 2
Engine Ignition Bus Voltage, On (vdc)	27.999*	Bus 4D11 ± 1
Engine Ifnition Bus Voltage, Off (vdc)	-0.030	0 ± 0.45
Component Test Power Current (amps)	0.200	0 ± 2
Component Test Power Voltage, On (vdc)	28.118	28 ± 2
Component Test Power Voltage, Off (vdc)	0.640	0 ± 1

*In tolerance, actual voltage limits not specified

4.4.8.1 (Continued)

Function	Measurement	Limits
Engine Control Bus Voltage, EDS 2 On (vdc)	-0.030	0 ± 0.450
Engine Control Bus Voltage, EDS 2 Off (vdc)	27.999*	Bus 4D11 ± 1
Propellant Level Sensor Pwr Current (amps)	0.000	1 ± 2
LOX Depletion Engine Cutoff Timer (sec)	0.566	0.560 ± 0.025
PU Inverter & Electronics Pwr Current (amps)	3.700	3 ± 2
PCM RF Assembly Power Current (amps)	4.200	4.5 ± 3.0
PCM RF Transmitter Output Power, AO (watts)	24.508	10 min
PCM RF Transmitter Output Power, BO (watts)	24.656	10 min
PCM RF Transmitter Output Power, AO T/M RF Silence On (watts)	-0.178	0 ± 2
Switch Selector Output Monitor, K128 (vdc)	2.015	2 ± 0.425
PCM RF Transmitter Output Power, AO, T/N RF Silence Off (watts)	25.132	10 min
Aft Bus 2 Current (amps)	0.000	5 max
Aft Bus 2 Voltage (vdc)	56.398	56 ± 1

Chilldown Inverter Tests

Function	LOX Inv.	LH_2 Inv.	Limits
Inverter Current (amps)	20.814	20.502	20.0 ± 5.0
Phase AB Voltage, Hardwire (vac)	55.082*	55.017*	Bus 4D41 ± 3
Phase AC Voltage, Hardwire (vac)	54.366*	54.300*	Bus 4D41 ± 3
Phase A1B1 Voltage, Hardwire (vac)	54.951*	54.951*	Bus 4D41 ± 3
Phase A1C1 Voltage, Hardwire (vac)	54.300*	54.366*	Bus 4D41 ± 3
Frequency, Hardwire (Hz)	402.000	400.000	400.0 ± 4.0
Phase AB Voltage, Telemetry (vac)	55.799*	55.998*	Bus 4D41 ± 3
Phase AC Voltage, Telemetry (vac)	56.198*	56.065*	Bus 4D41 ± 3
Frequency, Telemetry (Hz)	400.969	399.758	400.0 ± 4.0

Function	Measurement	Limits
Forward Battery 1 Simulator Voltage (vdc)	28.479	28 ± 2
Forward Battery 2 Simulator Voltage (vdc)	28.158	28 ± 2
Aft Battery 1 Simulator Voltage (vdc)	28.097	28 ± 2
Aft Battery 2 Simulaotr Voltage (vdc)	56.558	56 ± 4
Bus 4D20 ESE Load Bank (vdc)	0.000	0 ± 1
Bus 4D40 ESE Load Bank (vdc)	0.000	0 ± 1
Bus 4D30 ESE Load Bank (vdc)	0.039	0 ± 1
Bus 4D10 ESE Load Bank (vdc)	0.000	0 ± 1
Forward Bus 1 Voltage - Internal (vdc)	27.999	28 ± 2
Forward Bus 2 Voltage - Internal (vdc)	28.039	28 ± 2
Aft Bus 1 Voltage - Internal (vdc)	27.958	28 ± 2
Aft Bus 1 Voltage - External (vdc)	28.118	28 ± 2
Aft Battery 1 Voltage (vdc)	0.039	0 ± 1

*In tolerance, actual voltage limits not specified

4.4.8.1 (Continued)

Function	Measurement	Limits
Aft Bus 2 Voltage - Internal (vdc)	55.479	56 ± 4
Aft Bus 2 Voltage - External (vdc)	56.237	56 ± 4
Aft Battery 2 Voltage (vdc)	0.159	0 ± 1
Forward Bus 1 Voltage - External (vdc)	28.199	28 ± 2
Forward Battery 1 Voltage (vdc)	0.000	0 ± 1
Forward Bus 2 Voltage - External (vdc)	28.118	28 ± 2
Forward Battery 2 Voltage (vdc)	0.119	0 ± 1
Aft Bus 2 Voltage, Off (vdc)	0.000	0 ± 1
Range Safety Receiver 1 External Power Current (amps)	1.250	0 ± 2
Range Safety Receiver 2 External Power Current (amps)	1.249	0 ± 2

4.4.9 Hydraulic System Setup and Operation (1B41005 B)

The purpose of this manual procedure, initiated on 30 October 1968, and completed on 21 November 1968, was to ensure that the hydraulic system was correctly flushed, filled, bled, and maintained free of contamination during hydraulic system operation. The hydraulic system pressures and temperatures were checked for proper operational levels, the hydraulic system transducer circuits were tested for correct operation and response characteristics, and the J-2 engine operational clearance in the aft skirt was established.

Proper operation of the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454588; the main hydraulic actuator assemblies, P/N 1A66248-505-011, S/N 51 and P/N 1A66248-505-011, S/N 53; the main hydraulic pump, P/N 1A66240-503, S/N X454609; and the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00034, were verified during the course of this checkout.

Prior to operation of the stage hydraulic system, the hydraulic pumping unit (HPU), P/N 1A67443-1, was checked to ensure that the hydraulic fluid met the cleanliness requirements. The HPU was connected to the stage via the pressure and return hoses. Hydraulic fluid was circulated through the stage system to ensure that the system was properly filled, and hydraulic fluid samples were taken and certified to be free of contamination.

The accumulator/reservoir was charged with gaseous nitrogen, and the stage air bottles were charged to a pressure of 475 ±50 psig. The HPU was turned on; and the pressure compensator turned in the INCR direction until the system hydraulic pressure gauge indicated no further increase in pressure, but was less than 4400 psig. The stage hydraulic system was then checked for leaks.

4.4.9 (Continued)

On completion of the leak check, the pressure compensator on the HPU was turned in the DECR direction until the stage hydraulic system pressure reached 1500 ± 5 psig. The HPU bypass valve was opened, and the stage system pressure was further reduced to 1000 ± 50 psig. The auxiliary hydraulic pump was turned on and verified to be operating properly.

With the midstroke locks installed on the hydraulic actuators, the vernier scales were adjusted to read zero. The midstroke locks were then removed. The HPU was turned on, and the hydraulic system pressure was brought up to 3650 ± 50 psig. The pitch and yaw vernier scales were read, and the values were recorded in the Test Data Table. The HPU was turned off, and the midstroke locks were reinstalled.

The engine deflection clearance check was accomplished next. The gimbal control unit (GCU), P/N 1B50915, was installed and set up per H&CO 1B53382. The J-2 engine bellows protective covers were removed; and the platform extension, P/N 1B70620, was removed from the engine area. The J-2 engine restrainer and the hydraulic actuator midstroke locks were removed. After an inspection of the engine area for possible interference points, the HPU was turned on and the stage system pressure was brought up to 1000 psig. The pitch and yaw controls on the GCU were turned in the retract and extend directions. As the controls were moved, it was verified that the pitch and yaw actuators moved in relation to the direction and amplitude of the controls. By returning the pitch and yaw controls to center, the actuators were positioned to center; and the HPU was turned off. The midstroke locks and the J-2 engine bellows protective covers were reinstalled.

4.4.9 (Continued)

The shutdown sequence of this checkout included a final air content test which provided the information necessary for system analysis by discharging a portion of the internal system fluid volume overboard. The volume discharged was determined to be a function of the fluid temperature measurement to provide space in the reservoir for fluid thermal expansion under ground operating conditions (0-160°F). The HPU was turned on, and the system pressure was increased to 3650 ±50 psig. The bypass valve was opened, and the HPU was then turned off. Verification was made that the return pressure gauge indicated a minimum of 200 psig. The shutoff valve was cycled open and closed until the return pressure was reduced to 180 ±5 psig. An empty 100 ml graduate was placed under the drain port; and by cycling the reservoir drain valve open and closed, the return pressure was decreased to 80 ±5 psig. The volume of fluid bled was less than the 16 milliliters maximum as specified per design requirements.

A check to determine the pressure decay of the stage air bottles was conducted next. The air bottles were verified to be charged to 446 psia, well within the 475 ±50 psia limits, and the pressure and range time were recorded. After a lapse of 24 hours, the bottle pressure was remeasured and recorded as 448 psia, well within the allowable limits.

All data was reviewed, and this checkout was acceptable to Engineering. There were neither part shortages nor retest requirements pending that affected this test. FARR 500-489-618 reported that both the yaw and the pitch actuators were scratched in the area of the actuator lock grooves.

4.4.9 (Continued)

There were nine revisions written to the procedure for the following:

a. One revision authorized recharging the hydraulic accumulator. The first charging was 100 psi low.

b. One revision deleted the instrumentation support sections. These paragraphs were only applicable when the hydraulic system parameters were connected to the GIS hardwire system.

c. One revision authorized a test to verify proper operation of the hydraulic system pressure transducer prior to performing the hydraulic automatic procedure.

d. One revision reran the hydraulic system servicer as the HPU had been connected to the hydraulic system for more than 48 hours.

e. One revision checked for leakage at the system vent valve.

f. One revision provided instructions to secure the gimbal control unit after the engine clearance checks.

g. One revision deleted all sections pertaining to prefire or static firing checks.

h. One revision deleted the requirement to record the serial numbers of two transducers, C203 and C204, as the transducers were not installed on the stage. Also deleted was the serial number of measurement C051. This transducer had been wrapped with high temperature tape, and the serial number was not visible.

i. One revision provided detailed instructions for securing the hydraulic system prior to removing the stage from the test stand.

4.4.9.1 Test Data Table, Hydraulic System Setup and Operation

	Instrumentation			
Test Description	Name	Location	Actual	Requirement
Actuator Position	Pitch	Pitch	0 inches	0 inches
System Unpressurized	Vernier	Actuator		
	Yaw	Yaw	0 inches	0 inches
	Vernier	Actuator		

4.4.9.1 (Continued)

	Instrumentation			
Test Description	Name	Location	Actual	Requirement
Actuator Position	Pitch	Pitch	0 inches	Ref. Only
System Pressurized	Vernier	Actuator		
	Yaw	Yaw	0 inches	Ref. Only
	Vernier	Actuator		

4.4.10 Signal Conditioning Setup (1B64681 G)

This procedure calibrated the stage 5 volt and 20 volt excitation modules and calibrated any items of the stage signal conditioning equipment that were found to be out-of-tolerance during testing. The signal conditioning equipment consisted of those items required to convert transducer low level or ac signals to the 0 to 5 vdc form used by the telemetry system and included dc amplifiers, temperature bridges, frequency to dc converters, and expanded scale voltage monitors. Only the particular items calibrated during this procedure are noted below and in Test Data Table 4.4.10.1.

The procedure was initiated on 30 October 1968, and was certified as completed on 19 November 1968. The stage power setup, H&CO 1B55813, was performed prior to any calibration activity to provide electrical power to the equipment.

Three 5 volt excitation modules were calibrated. The input voltage to each module was verified to be 28 ±0.1 vdc; and each module was adjusted to obtain a 5 vdc output of 5.0 ±0.005 vdc, a -20 vdc output of -20.00 ±0.005 vdc, and an ac output of 10 ±1 volt peak-to-peak at 2000 ±200Hz. The final values measured, as shown in the Test Data Table, were all within the above limits. The ac output measurements were made with the test switch set to four different positions, sequentially, and were found to be the same for each position.

Nine 20 volt excitation modules were calibrated by adjusting the coarse control and fine control on each module to obtain an output of 20.000 ±0.005 vdc. As shown in the Test Data Table, the final measured value for each module was within the above limits.

4.4.10 (Continued)

One temperature bridge required calibration. This was the cold helium bottle manifold temperature, measurement C2039, temperature bridge 411A61A251, P/N 1B76359-501, S/N 05. With a low level calibration input, the temperature bridge was adjusted to obtain a bridge output of 0.000 vdc, within the 0.000 ±0.005 vdc limits. With a high level calibration input, the bridge output was verified to be 4.000 vdc, within the 4.000 ±0.005 vdc limits.

Four hydraulic pressure transducer ambient outputs were measured and recorded in the Test Data Table.

Thirty-eight strain gauges and the associated dc amplifiers were calibrated. Adjustment of the dc amplifiers for low output, high output, and an operating level was required. The output values were measured and listed in the Test Data Table.

One expanded scale monitor module was checked by calibrating the associated dc amplifier. This was the inverter-converter 5 volt monitor, measurement M4, expanded scale voltage, P/N 1A95181-1, S/N 026, and dc amplifier 411A61A254, P/N 1A82395-1, S/N 2457. With a low RACS command on, the dc amplifier zero control was adjusted to obtain a zero output of 0.000 vdc, meeting the 0.000 ±0.005 vdc limit. With a high RACS command on, the amplifier gain control was adjusted to obtain a gain output of 4.000 vdc, meeting the 4.0 ±0.005 vdc limit.

No part shortages were recorded that affected this test; however, two Failure and Rejection Reports (FARR's) were written as a result of this procedure.

4.4.10 (Continued)

FARR 500-489-316 reported that the strain gauge bridge module, P/N 1B68859-503, S/N 049, would not indicate a reading lower than 0.060 vdc. The lower limit tolerance was expressed as 0.000 $\pm$0.005 vdc. The discrepant module was removed and replaced. FARR 500-489-502 reported that pin N of module, P/N 1A84763-511, S/N 0151, was bent and that cable assembly, P/N 1B76206-1, had a damaged insert on plug P3 by socket N. The bent pin was straightened, and the damaged plug was removed and replaced.

Ten revisions were made to this procedure for the following:

a. One revision added the checkout and calibration instructions for the thirty-eight strain gauges that were added per ECP 4041.

b. One revision added the requirement for calibration of temperature bridge C2039. This parameter was added to the stage after release of this procedure.

c. One revision added two 20 volt excitation modules erroneously omitted from the procedure.

d. One revision gave instructions to readjust the signal conditioning modules for measurements 579, 365, and 367. These measurement were near the tolerance limits during DDAS automatic procedure.

e. One revision repeated the setups for strain gauge bridge S84. This strain gauge was removed and replaced on FARR 500-489-316.

f. One revision reverified the setups for strain gauges S104, S105, S106, S107, S102, and S103 prior to the performance of the FM/SSB procedure.

g. One revision changed the setup requirements for measurement S102. The original setup instructions were in error.

h. One revision added the calibration instructions for measurement S63. This parameter indicated an out-of-tolerance condition during attempt number 3 of DDAS.

i. One revision voided a previous revision.

4.4.10 (Continued)

j. One revision deleted all portions of the procedure except the sections pertaining to those measurements that were found to be out-of-tolerance or were removed and replaced subsequent to checkout of that parameter.

4.4.10.1 Test Data Table, Signal Conditioning Setup

5 Volt Excitation Module - P/N 1A77310-503.1

Reference Location	S/N	5 vdc Output (vdc)	-20 vdc Output (vdc)	ac Output (vpp)	kHz
404A52A7	0171	4.999	-19.998	9.5	19,983
411A98A2	0103	4.999	-19.996	9.5	20,067
411A99A33	0170	4.999	-20.003	9.5	19.965

20 Volt Excitation Module - P/N 1A74036-1.1

Reference Location	S/N	20 vdc Output (vdc)	Tolerance (vdc)
411A61A242	0368	20.000	20.0 $\pm$ 0.005
404A62A241	0307	19.998	20.0 $\pm$ 0.005
404A63A241	0279	20.002	20.0 $\pm$ 0.005
404A64A241	0311	20.000	20.0 $\pm$ 0.005
404A65A241	0208	20.002	20.0 $\pm$ 0.005
404A63A233	0231	20.000	20.0 $\pm$ 0.005
404A66A241	0325	20.000	20.0 $\pm$ 0.005
404A67A241	0346	20.000	20.0 $\pm$ 0.005
404A68A241	0343	20.000	20.0 $\pm$ 0.005

Temperature Bridge - P/N 1B76359-501

Reference Location	S/N	Output (vdc) Zero Reading	Zero Tolerance	Gain Reading	Gain Tolerance
411A61A251	05	0.000	0.0 $\pm$ 0.005	4.000	4.0 $\pm$ 0.005

Hydraulic Pressure Transducer - Ambient Output

Measurement Number	P/N	S/N	Output Pressure Reading	Output Pressure Tolerance
D42	1B31356-517	341-1	19.2 psia	14.7 $\pm$ 8 psia
D43	1B31356-513	314-1	1396 psia	1395 $\pm$ 50 psia
D209	1B31356-505	019-1	1.05 psig	0 $\pm$ 1.2 psig
D223	1B31356-509	254-1	17.7 psia	14.7 $\pm$ 13 psia

4.4.10.1 (Continued)

Strain Gauge Calibration

Aft Rack Assembly - P/N 1B55688-559, S/N 077

	RACS (vdc)					
Meas.	Low		High		Run	
No.	Reading	Tolerance	Reading	Tolerance	Reading	Tolerance
S70	1.804	1.8 ± 0.005	4.800	4.8 ± 0.005	0.798	0.8 ± 0.025
S71	1.803	1.8 ± 0.005	4.799	4.8 ± 0.005	0.793	0.8 ± 0.025
S72	1.798	1.8 ± 0.005	4.803	4.8 ± 0.005	0.806	0.8 ± 0.025
A73	1.796	1.8 ± 0.005	4.804	4.8 ± 0.005	0.804	0.8 ± 0.025
A74	1.802	1.8 ± 0.005	4.797	4.8 ± 0.005	0.807	0.8 ± 0.025
A75	1.798	1.8 ± 0.005	4.804	4.8 ± 0.005	0.803	0.8 ± 0.025
S76	1.801	1.8 ± 0.005	4.798	4.8 ± 0.005	0.805	0.8 ± 0.025
S77	1.797	1.8 ± 0.005	4.803	4.8 ± 0.005	0.807	0.8 ± 0.025
S78	1.798	1.8 ± 0.005	4.800	4.8 ± 0.005	0.806	0.8 ± 0.025
S79	1.797	1.8 ± 0.005	4.801	4.8 ± 0.005	0.805	0.8 ± 0.025
S80	1.798	1.8 ± 0.005	4.800	4.8 ± 0.005	0.805	0.8 ± 0.025
S81	1.797	1.8 ± 0.005	4.803	4.8 ± 0.005	0.804	0.8 ± 0.025
S82	1.799	1.8 ± 0.005	4.799	4.8 ± 0.005	0.808	0.8 ± 0.025
S83	1.798	1.8 ± 0.005	4.803	4.8 ± 0.005	0.805	0.8 ± 0.025
S84	1.798	1.8 ± 0.005	4.800	4.8 ± 0.005	0.806	0.8 ± 0.025
S85	1.798	1.8 ± 0.005	4.800	4.8 ± 0.005	0.803	0.8 ± 0.025
S104	4.200	4.2 ± 0.005	Off-Scale	Off-Scale	2.499	2.5 ± 0.025
S105	4.200	4.2 ± 0.005	Off-Scale	Off-Scale	2.499	2.5 ± 0.025
S106	4.199	4.2 ± 0.005	Off-Scale	Off-Scale	2.496	2.5 ± 0.025
S107	4.200	4.2 ± 0.005	Off-Scale	Off-Scale	2.497	2.5 ± 0.025
S102	4.199	4.2 ± 0.005	Off-Scale	Off-Scale	2.496	2.5 ± 0.025

Forward Rack Assembly - P/N 1B55689-523, S/N 023

S54	1.900	1.9 ± 0.005	4.903	4.9 ± 0.005	0.905	0.9 ± 0.025
S55	1.898	1.9 ± 0.005	4.900	4.9 ± 0.005	0.903	0.9 ± 0.025
S56	1.902	1.9 ± 0.005	4.901	4.9 ± 0.005	0.906	0.9 ± 0.025
S57	1.899	1.9 ± 0.005	4.900	4.9 ± 0.005	0.906	0.9 ± 0.025
S58	1.900	1.9 ± 0.005	4.902	4.9 ± 0.005	0.904	0.9 ± 0.025
S59	1.898	1.9 ± 0.005	4.902	4.9 ± 0.005	0.903	0.9 ± 0.025
S60	1.902	1.9 ± 0.005	4.904	4.9 ± 0.005	0.903	0.9 ± 0.025
S61	1.898	1.9 ± 0.005	4.904	4.9 ± 0.005	0.902	0.9 ± 0.025
S62	1.897	1.9 ± 0.005	4.898	4.9 ± 0.005	0.899	0.9 ± 0.025
S63	1.897	1.9 ± 0.005	4.902	4.9 ± 0.005	0.900	0.9 ± 0.025
S64	1.897	1.9 ± 0.005	4.903	4.9 ± 0.005	0.904	0.9 ± 0.025
S65	1.898	1.9 ± 0.005	4.902	4.9 ± 0.005	0.898	0.9 ± 0.025
S66	1.904	1.9 ± 0.005	4.900	4.9 ± 0.005	0.901	0.9 ± 0.025
S67	1.904	1.9 ± 0.005	4.901	4.9 ± 0.005	0.902	0.9 ± 0.025
S68	1.903	1.9 ± 0.005	4.898	4.9 ± 0.005	0.899	0.9 ± 0.025
S69	1.904	1.9 ± 0.005	4.900	4.9 ± 0.005	0.901	0.9 ± 0.025

4.4.10.1 (Continued)

Meas. No.	RACS (vdc) Low Reading	Tolerance	High Reading	Tolerance	Run Reading	Tolerance
Aft Rack Assembly - P/N 1B55688-569, S/N 078						
S103	0.768	0.766 ± 0.005	4.234	4.234 ± 0.005	2.501	2.5 ± 0.025

4.4.11 Auxiliary Propulsion System (1B55825 E)

The auxiliary propulsion system test verified the integrity of the stage wiring associated with APS functions and verified receipt of command signals routed from the GSE automatic checkout system, through the attitude control relay packages, to the APS electrical interfaces. The APS simulators, used in place of the APS flight modules for this test, did not functionally simulate the APS modules, but provided suitable loads at the electrical interface to determine that the stage mounted components of the APS functioned properly.

All stage mounted components of the APS were tested, in particular, the attitude control relay packages, P/N 1B76452-1, S/N 418, at reference location 404A51A4 and S/N 417, at reference location 404A71A19.

The procedure was satisfactorily accomplished and completed on 30 October 1968, and accepted on 1 November 1968. After initial conditions were established, the GSE IU substitute -28 vdc power supply was turned on. The APS firing enable command and the APS bus power were turned on. A series of tests were then conducted to verify the proper operation of the APS engine valve solenoids. The attitude control nozzle commands were turned on, and the appropriate APS engine valve open indication was verified.

The attitude control nozzle command was then turned off, and the valve open indication was again verified. The 70 pound ullage engine commands 1 and 2 were then individually turned on and off, while the ullage engine relay reset was verified to operate properly. At the conslusion of these tests, the stage was returned to the pretest configuration, thereby completing the test procedure.

4.4.11 (Continued)

Engineering comments indicated that there were no part shortages that would affect this test. No problems were encountered during the test, and no FARR's were written.

Two revisions were made to the procedure concerning malfunctions received during initial condition scan. These valve malfunctions were due to the valves not being electrically connected. Correct operation of the valves was verified by subsequent initial condition scans.

4.4.11.1 Test Data Table, Auxiliary Propulsion System

Attitude Control Nozzle Command		APS Engine	AO Multiplexer	BO Multiplexer	Limits
Nozzle I IV	On	1-1 or 1-3	3.805	3.802	4.0 ± 0.25
	Off	1-1 or 1-3	0.00	0.00	0.0 ± 0.25
Nozzle I II	On	1-1 or 1-3	3.759	3.777	4.0 ± 0.25
	Off	1-1 or 1-3	-0.005	-0.005	0.0 ± 0.25
Nozzle I P	On	1-2	3.814	3.825	4.0 ± 0.25
	Off	1-2	-0.005	-0.005	0.0 ± 0.25
Nozzle III II	On	2-1 or 2-3	3.697	3.712	3.9 ± 0.25
	Off	2-1 or 2-3	0.00	0.00	0.0 ± 0.25
Nozzle III IV	On	2-1 or 2-3	3.666	3.677	3.9 ± 0.25
	Off	2-1 or 2-3	0.005	0.005	0.0 ± 0.25
Nozzle III P	On	2-2	3.748	3.769	3.9 ± 0.25
	Off	2-2	-0.005	-0.005	0.0 ± 0.25

4.4.12 Digital Data Acquisition System Calibration (1B55816 G)

This procedure provided the manual and automatic operations for the checkout and calibration of the digital data acquisition system (DDAS) and prepared the system for use. The integrity of the DDAS was verified from data inputs through the various multiplexers and the PCM/DDAS assembly to the DDAS ground station. The items involved in this test were the PCM/DDAS assembly, P/N 1B65792-1, S/N 670092; CP1-BO time division multiplexer, P/N 1B62513-547, S/N 013; DP1-BO time division multiplexer, P/N 1B62513-543, S/N 014; remote digital submultiplexer (RDSM), P/N 1B52894-501, S/N 025; and low level remote analog submultiplexer (RASM), P/N 1B66050-501, S/N 08.

This test was initiated on 31 October 1968, and acceptance occurred on 1 November 1968.

The stage power was turned on per H&CO 1B55813, and initial conditions were established for the stage and DDAS. The 72 kHz bit rate check was made on the PCM data train to ensure that the frequency was within tolerance. The 72 kHz bit rate was measured as 72,004 bits per second, well within the 71,975 to 72,025 bits per second limits. The 600 kHz VCO test was accomplished by measuring the band edge frequencies and voltages of the PCM/DDAS VCO output. The upper band edge frequency was measured at 633.98 kHz at 2.9 vrms, within the acceptable limits of 623.2 kHz to 643.2 kHz, at greater than 2.2 vrms. The lower band edge frequency was measured at 567.73 kHz at 2.9 vrms, within the acceptable limits of 556.8 kHz to 576.8 kHz, at greater than 2.2 vrms. The frequency differential was calculated as 66.25 kHz, within the acceptable limits of 60 to 80 kHz.

4.4.12 (Continued)

The next tests performed were the automatic flight calibration checks and the individual multiplexer checks of the CP1-BO and DP1-BO multiplexers. The outputs of the multiplexer data channels were recorded for each of the calibration and input levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc. All measured channels were within the required tolerances.

The RDSM was verified by inserting signal levels equivalent to ones (20 vdc) and zeros (0 vdc) into the RDSM input circuits and by checking the output at the computer for a digital word of corresponding ones and zeros. The RASM was verified by inserting signal voltages, 0 to 30 millivolts, which were amplified to an output range of 0 to 5 volts dc corresponding to the 0 to 30 millivolt range input. All measured outputs for the RDSM and the RASM were within the required tolerances.

A final test measured the PCM/FM transmitter current as 4.7 amperes, within the 4.5 ±3.00 amperes limit.

There were six revisions written to the procedure for the following:

a. Two revisions concerned program errors or changes to update the procedure.

b. Two revisions stated that the malfunctions during the IC scan were due to the values involved not being electrically connected or being used to support propulsion system leak checks.

c. One revision attributed a malfunction to the deletion of a portion of the procedure by an earlier revision.

d. One revision stated that the malfunction of the RASM test occurred because a capacitor was installed with the polarity reversed. The connection was corrected, and no further malfunctions occurred.

4.4.13 Exploding Bridgewire System (1B55822 F)

This automatic procedure verified the design integrity of the exploding bridgewire (EBW) system and demonstrated the operational capability of the EBW system to initiate ullage rocket ignition and jettison when commanded by the instrument unit during flight. The particular items involved in this test were:

Part Name	Ref. Location	P/N	S/N
Ullage Rocket Ignition System			
EBW Firing Unit	404A47A1	40M39515-113	285
EBW Firing Unit	404A47A2	40M39515-113	282
Pulse Sensor *	404A47A4A2	40M02852	-
Pulse Sensor *	404A7A4A2	40M02852	-
* On Pulse Sensor Bracket Assy	404A47A4	1B52640-1	1
Ullage Rocket Jettison System			
EBW Firing Unit	404A75A1	40M39515-113	277
EBW Firing Unit	404A74A2	40M39515-113	283
Pulse Sensor **	404A75A10A1	40M02852	-
Pulse Sensor **	404A75A10A2	40M02852	-
** On Pulse Sensor Bracket Assy	404A75A10	1A97791-501	3

This procedure was accomplished on 31 October 1968, and was accepted on the same date. Throughout this procedure the charged condition of each EBW firing unit was determined by verifying that the firing unit voltage indication measured 4.2 $\pm$0.3 vdc, while the uncharged or discharged condition was determined by verifying that the voltage indication measured 0.0 $\pm$0.3 vdc, or during the firing unit disable test, 0.2 $\pm$0.3 vdc.

The stage power setup, H&CO 1B55813, was accomplished and initial conditions were established. An EBW pulse sensor self test was conducted first by

4.4.13 (Continued)

verifying that the self test command properly turned on the four EBW pulse sensors and that the reset command properly turned off the pulse sensors.

The ullage ignition EBW firing units were tested next. The charge ullage ignition command was verified to properly charge both ullage ignition EBW firing units, while both ullage jettison EBW firing units remained uncharged. To verify that the fire ullage ignition command properly fired the ullage ignition EBW firing units, it was determined that both ignition pulse sensors were turned on while both jettison pulse sensors remained off and that both ullage ignition EBW firing units were discharged.

The ullage jettison EBW firing units were tested in the same way by verifying that the charge ullage jettison command charged the ullage jettison EBW firing units and that the fire ullage jettison command fired the jettison firing units and turned on the jettison pulse sensors.

A series of checks then verified that the EBW ullage rocket firing unit disable command prevented the firing units from charging, when the charge ullage ignition and charge ullage jettison commands were turned on, and discharged the firing units, while preventing them from firing when the fire ullage ignition and fire ullage jettison commands were turned on.

A final series of checks verified the operation of the EBW pilot relay by determining that the pilot relay reset indication was off after each of the charge ullage ignition and jettison, and fire ullage ignition and jettison commands were turned on, and that the pilot relay reset indication was on after each command was reset.

4.4.13 (Continued)

Engineering comments noted that all parts were installed at the start of this checkout. No problems were encountered during this test, and no FARR's were written. Three revisions were made to the procedure for the following:

a. Two revisions attributed eight malfunctions to valves not being electrically connect or being utilized to support propulsion system leak checks.

b. One revision was required to correct a typographical error.

4.4.14 Postmodification Structural Inspection (1B70756 B)

This manual procedure outlined the postmodification inspection requirements for the stage. The purpose of the checkout was to verify that the storage and modifications were not detrimental to the stage structure and that the stage was structurally ready for flight.

The procedure was initiated on 2 November 1968, with the inspection of the "V-section", between the thrust structure and the aft dome, for foreign material which could result in damage to the LOX tank during pressurization.

Verification was made that all stage hardware did not extend more than 8 inches from the outer surface of the forward dome of the LH2 tank, with the exception of the temperature transducer, P/N 1B67863.

No shortages were listed and no FARRs were initiated as a result of this procedure.

Five revisions were written for the following:

a. One revision deleted steps that were completed in previous issues of this procedure.

b. One revision deleted the LH2 tank internal inspection.

c. One revision authorized the cleaning and inspection of the "V-section", between the thrust structure and the aft dome, for removal of foreign material to prevent damage to the LOX tank during pressurization.

d. Two revisions deleted sections that were accomplished on later documentation.

4.4.15 Cryogenic Temperature Sensor Verification (1B64678 F)

The calibration and functional capabilities of the cryogenic temperature sensors, for which the normal operating range did not include ambient temperatures, were verified by this manual procedure. The cryogenic temperature sensors, basically platinum resistance elements, changed resistance according to the Callendar-Van Dusen equation.

Resistance and continuity checks of the internal fuel tank temperature transducers were conducted by three issues of the procedure. The first issue, conducted on 4 November 1968, and accepted on 7 November 1968, was required due to rework activity within the fuel tank subsequent to static firing. A second issue, accomplished and accepted on 25 November 1968, was performed as a part of the postmodification structural inspection. The final issue was necessitated by removal of the LH_2 PU probe for cleaning. The third issue was accomplished and accepted on 27 November 1968.

The test sequences consisted of sensor element resistance checks and sensor wiring continuity checks. The sensor element resistance was measured for each of the transducers at the ambient room temperature with a General Radio, Model 1652A, resistance limit bridge. The ambient temperature was measured and recorded for each sensor. The checkout sensor parameter table specified the resistance value at $32^{\circ}F$ for each sensor and its change in resistance for each degree between $32^{\circ}F$ and $100^{\circ}F$. Using these values, the required resistance at the recorded ambient temperature was calculated and compared with the actual resistance measured to determine acceptability for each sensor. A tolerance

4.4.15 (Continued)

of ± 5 to ± 7 per cent of the calculated resistance (depending on sensor part number) was allowed for acceptance of the actual resistance measurements.

A check for correct sensor wiring (continuity) was accomplished by connecting a jumper wire on the adapter cable, P/N 1B64095-1, and verifying that the sensor element for each transducer was shorted out to a resistance measurement of 5 ohms or less.

Thirteen revisions to the three issues of the procedure were written for the following:

a. Nine revisions concerned additional parameters and changes required to update the procedure to the latest configuration.

b. Two revision were required to correct typographical errors.

c. Two revisions deleted all sections except for LH_2 measurements C-0052, C-0370, and C-0371.

4.4.15.1 Test Data Table, Cryogenic Temperature Sensor Verification

Meas. No.	Sensor P/N	Sensor S/N	Sensor Ref Desig	Temp (°F)	Resistance (ohms) Meas	Resistance (ohms) Calc	Resistance (ohms) ±Tol	Cont
C-0368	1A67862-505	80182	406MT660	67	539.0	538.5	26.93	1.5
C-0369	1A67862-505	80145	406MT661	67	539.0	538.5	26.93	1.05
C-0256	1B37878-501	1431	409MT646	59	1470.0	1482.0	74.0	0.08
C-0371	1B51648-507	64395	408MT736	66	5110.0	5374.0	376.0	1.50
C-0059	1A67862-517	51424	406MT611	67	540.0	538.5	26.93	1.38
C-0057	1A67862-501	551	406MT606	67	539.0	538.5	26.93	1.18
C-0230	1A67863-539	1429	403MT706	67	533.0	538.5	26.93	0.95
C-0257	1B37878-501	1418	409MT647	59	1480.0	1482.0	74.0	0.7
C-0161	1B37873-537	1172	404MT733	60	5000.0	5308.0	371.5	0.6
C-0159	1A67863-519	785	424MT610	62	215.0	213.0	10.66	0.85
C-0231	1A67863-529	1064	403MT707	67	534.0	538.5	26.93	1.05
C-0370	1B51648-507	59802	408MT735	66	5172.6	5374.0	376.0	1.6
C-2030	1B37878-511	1275	404MT760	62	534.0	533.0	26.7	0.9
C-2031	1B37878-511	1814	404MT761	62	533.0	533.0	26.7	0.75

4.4.15.1 (Continued)

Meas. No.	P/N	S/N	Ref Desig	Temp (°F)	Meas	Calc	±Tol	Cont
C-0012	NA5-27215T5	13538	404(4MT72)	67	1310.0	1352.6	67.63	1.5
C-0015	1A67863-539	1424	410MT603	57	528.0	527.7	26.4	1.0
C-0040	1A67863-535	564	406MT613	67	1480.0	1486.4	74.25	1.1
C-0209	1A67873-503	1274	405MT606	62	526.0	533.0	29.6	1.7
C-0384	1B37878-511	1471	403MT779	62	535.0	533.0	29.6	0.85
C-0391	1A68589-519	H94	403MT784	72	11.5	11.0	0.55	1.4
C-0052	1A67862-513	316	408MT612	66	5380.0	5394.0	376.0	1.5
C-0208	1A67863-503	856	405MT605	67	528.0	538.5	26.93	1.25
C-0005	1A67863-503	868	405MT612	67	530.0	538.5	26.93	1.40
C-0003	1B34473-1	334	403MT686	66	5110.0	5374.0	376.0	1.10
C-0004	1B34473-501	323	403MT687	67	1500.0	1507.8	75.39	1.50
C-0134	NA5-27215T5	13535	401(3MT16)	62	1324.0	1338.8	66.9	0.75
O_2H_2 Voter 1	1B37878-507	1693	403A20	62	5140.0	5330.0	366.5	0.75
O_2H_2 Voter 2	1B37878-507	1691	403A21	62	5150.0	5330.0	366.5	0.75
O_2H_2 Voter 3	1B37878-507	1692	403A22	39	5000.0	5077.0	355.4	0.70

4.4.16 Level Sensor and Control Unit Calibration (1B64680 D)

This manual procedure determined that the control units associated with the LOX and LH_2 liquid level, point level, fast fill, and overfill sensors, were adjusted for operating points within the design calibration limits. The particular items involved in this test are noted in Test Data Table 4.4.16.1.

This procedure was initiated on 5 November 1968, and completed 11 November 1968.

The point level sensor manual checkout assembly, P/N 1B50928-1, and a variable precision capacitor, General Radio Type 1422 CD, were used during the test to provide capacitance changes to the control units as required to simulate wet conditions and to determine the control unit operating points.

The manual checkout assembly was connected between each control unit and its associated sensor, and the precision capacitor was connected to the checkout assembly to parallel the sensor capacitance. A voltmeter, connected to the appropriate checkout assembly test points, measured the control unit output signal. The precision capacitor, set to an appropriate capacitance for the sensor under test, simulated a wet condition for the appropriate level sensor. The required settings for the precision capacitor were: 0.7 $\pm$0.01 picofarads for all LH_2 sensors with the exception of the LH_2 overfill sensor, which required 1.10 $\pm$0.02 picofarads; and 1.50 $\pm$0.02 picofarads for all LOX sensors except the LOX overfill sensor, which required 2.10 $\pm$0.02 picofarads. The control unit power was turned on, and the control point adjustment, R1, on the unit under test was adjusted until the control unit output signal increased from 0.0 $\pm$1.1 vdc to 28.0 $\pm$2.0 vdc, indicating activation of the

4.4.16 (Continued)

of the control unit output relay. The capacitance value of the precision capacitor was reduced until the control unit output relay deactivated; then, the deactivation capacitance value was recorded. The capacitance value of the precision capacitor was increased until the control unit output relay reactivated. The reactivation capacitance was also recorded, as shown in Test Data Table 4.4.16.1.

The capacitance checks were followed by a series of tests to verify operation of the output relay. With the sensor reconnected, the output relay for each control unit was reverified to be deactivated under normal conditions and activated under test conditions.

There were no part shortages that affected this test. No problems were encountered, and no FARR's were written. Two revisions were written to clarify the procedure.

4.4.16.1 Test Data Table, Level Sensor and Control Unit Calibration

	Sensor P/N 1A68710			Control Unit P/N 1A68710 -509		Capacitance (pf)		
Function	Ref. Loc.	Dash No.	S/N	Ref. Loc.	S/N	Act. Meas.	Deact. Meas.	Tolerance
LH_2 Tank	408			411				
Liq. Lev. L17	MT732	-507	D72	A61A217	D99	0.681	0.667	0.7 ± 0.15
Liq. Lev. L18	MT733	-507	D76	A61A219	D-27	0.670	0.660	0.7 ± 0.15
Liq. Lev. L19	MT734	-507	D119	A61A221	D95	0.710	0.696	0.7 ± 0.15
Pt. Lev. 1	A2C1	-507	D74	A92A25	D118	0.680	0.670	0.7 ± 0.15
Pt. Lev. 2	A2C2	-507	D-77	A92A26	D117	0.717	0.708	0.7 ± 0.15
Pt. Lev. 3	A2C3	-507	D-80	A92A27	C-6	0.708	0.699	0.7 ± 0.15
Pt. Lev. 4	A2C4	-507	D83	A61A201	D120	0.707	0.698	0.7 ± 0.15
Fastfill	A2C5	-1	D89	A92A43	D121	0.791	0.778	0.7 ± 0.15
Overfill	*	*	*	A92A24	D116	1.101	1.082	1.1 ± 0.15

* Part of LH_2 mass probe, P/N 1A48431-513, S/N D4, 408A1

4.4.16.1 (Continued)

Function	Sensor P/N 1A68710 Ref. Loc.	Dash No.	S/N	Control Unit P/N 1A68710 -511 Ref. Loc.	S/N	Capacitance (pf) Act. Meas.	Deact. Meas.	Tolerance
LOX Tank	406			404				
Liq. Lev. L14	MT657	-1	D82	A63A221	D-82	1.504	1.499	1.5 ± 0.15
Liq. Lev. L15	MT658	-1	D78	A63A206	D122	1.510	1.505	1.5 ± 0.15
Liq. Lev. L16	MT659	-1	D76	A63A223	D121	1.469	1.461	1.5 ± 0.15
Pt. Lev. 1	A2C1	-1	D105	A72A1	D104	1.486	1.481	1.5 ± 0.15
Pt. Lev. 2	A2C2	-1	D122	A72A2	D98	1.489	1.486	1.5 ± 0.15
Pt. Lev. 3	A2C3	-1	D124	A72A3	D96	1.477	1.476	1.5 ± 0.15
Pt. Lev. 4	A2C4	-1	D129	A63A227	D126	1.486	1.478	1.5 ± 0.15
Fastfill	A2C5	-1	D90	A72A5	C16†	1.435	1.427	1.5 ± 0.15
Overfill	**	**	**	A72A4	D128†	2.079	2.077	2.1 ± 0.15

**Part of LOX mass probe, P/N 1A48430-509, S/N D9, 406A1
†The configuration for this part is -511.1

4.4.17 Propellant Utilization System Calibration (1B64367 J)

Calibration and operation instructions for the propellant utilization (PU) system were provided by this manual checkout. For calibration purposes, the propellant utilization test set (PUT/S), P/N 1A68014-1, was utilized to provide varying capacitance inputs to the propellant utilization electronics assembly (PUEA) to simulate the LOX and LH_2 mass probe outputs under varying propellant load conditions.

The items involved in this test included:

Part Name	Ref Location	P/N	S/N
Propellant Utilization Electronics Assy	411A92A6	1A59358-525	0004
Static Inverter-Converter	411A92A7	1A66212-507	025
LOX Mass Probe	406A1	1A48430-509	D9
LH_2 Mass Probe	408A1	1A48431-515	D4
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511.1	D128
LOX Fastfill Sensor	406A2C5	1A68710-1	D90
LOX Fastfill Control Unit	404A7A5	1A68710-511.1	C16
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D116
LH_2 Fastfill Sensor	408A2C5	1A68710-1	D89
LH_2 Fastfill Control Unit	411A92A43	1A68710-509	D121

Initiated on 6 November 1968, the PU system calibration was completed and accepted on the same date. Megohm resistance measurements of the LOX and LH_2 mass probes were verified to be greater than the 1000 megohm minimum requirement. The output voltage and operating frequency of the static inverter-converter were measured, and the resulting values were within the specified limits. The PUEA LH_2 bridge was calibrated for the empty condition by nulling the PUT/S ratiometer at a reading of 0.0061 then nulling the PUEA R2 potentiometer. The PUEA LOX bridge was calibrated for the empty condition by

4.4.17 (Continued)

nulling the PUT/S ratiometer to a reading of 0.0202, and then nulling the PUEA P1 potentiometer. The PUEA LH_2 and LOX bridges were calibrated for full conditions by setting the PUT/S ratiometer to 0.8204 and nulling the LH_2 and LOX bridge potentiometers.

Data acquisition was verified by establishing simulated empty and full conditions and determining the PUT/S ratiometer settings required to null the PUEA LH_2 and LOX bridges. All values obtained were within the required limits. The bridge slew checks were conducted by simulating 1/3 and 2/3 slew conditions and determining the PUT/S ratiometer settings required to null the PUEA LH_2 and LOX bridges for each case.

The reference mixture ratio (RMR) calibration was then accomplished. The first step consisted of determining the difference between the LOX and LH_2 empty ratiometer readings and multiplying this difference by 98.4 vdc. The resultant product was designated as VI. Simulated empty conditions were setup and the PUEA residual empty bias potentiometer R6 was nulled. Simulated full conditions were then established with the PUT/S C1 (LH_2) capacitor set to 182.33 picofarads and the C2 (LOX) capacitor set to 122.67 picofarads. The residual full bias potentiometer R5 on the PUEA was set to the null position. The bridge linearity checks were then accomplished by adjusting the PUT/S capacitors C1 (LH_2) and C2 (LOX) to specific values and determining the PUT/S ratiometer settings required to null the PUEA bridges. The hardwire loading voltages of the LH_2 and LOX bridges were checked and found to be within the specified tolerance of 23.6 $\pm$2.0 vdc.

4.4.17 (Continued)

All required parts were installed at the start of this checkout. No problems were encountered during the procedure, and no FARR's were written as a result of this checkout.

Twenty-one revisions were written during the procedure for the following:

a. Thirteen revisions added, deleted, or changed requirements to update or correct the procedure.

b. Seven revisions revised instructions to clarify the procedure.

c. One revision added the requirement to record the serial numbers of the PUEA and the static inverter-converter per a NASA request.

4.4.17.1 Test Data Table, Propellant Utilization System Calibration

Function	Measured Value	Limits
Static Inverter Output		
5 vdc (vdc)	4.92	4.75 to 5.05
21 vdc (vdc)	20.9	20 to 22.5
28 vdc (vdc)	27.5	26 to 30
V/P Excitation (vdc)	49.1	47.2 to 50.31
115 VRMS Monitor (vdc)	2.71	2.28 to 3.18
117 vdc (vdc)	117.0	115 to 122.5
TP_2 Reading (vdc)	21.1	20 to 22.5
Frequency Output (Hz)	396.0	394 to 406
Data Acquisition (Ratios)		
LH_2 Empty	0.00015	*
LOX Empty	0.02087	*
LH_2 Full	0.82304	*
LOX Full	0.82549	*
Bridge Slew Checks (Ratios)		
LH_2 1/3 Slew	0.30980	*
LH_2 2/3 Slew	0.64000	*
LOX 1/3 Slew	0.28475	*
LOX 2/3 Slew	0.57358	*

* Limits not specified

4.4.17.1 (Continued)

Function	Measured Value	Limits
LH_2 Bridge Linearity Check (Ratios)		
36.41 pf	0.15954	0.15796 to 0.16126
72.82 pf	0.32510	0.32379 to 0.32709
109.22 pf	0.49060	0.48967 to 0.49297
145.63 pf	0.65629	0.65551 to 0.65881
182.04 pf	0.82315	0.82139 to 0.82469
LOX Bridge Linearity Check (Ratios)		
24.5 pf	0.18150	0.17998 to 0.18328
49.01 pf	0.34241	0.34096 to 0.34426
73.51 pf	0.50292	0.50194 to 0.50524
98.02 pf	0.66409	0.66292 to 0.66622
122.52 pf	0.82551	0.82390 to 0.82720

4.4.18 Propellant Utilization System (1B55823 J)

This automatic checkout verified the capability of the propellant utilization (PU) system to determine and control the engine propellant flow mixture ratio in a manner that ensured simultaneous propellant depletion. The test also verified the capability of the PU system to provide propellant level information for controlling the fill and topping valves during LOX and LH_2 loading operations. The automatic checkout system (ACS) was utilized during testing to function PU system components and to monitor responses. This test involved all components of the stage PU system including:

Part Name	Ref. Location	P/N	S/N
Propellant Utilization Electronics Assy	411A92A6	1A59358-525	00004
Static Inverter-Conterter	411A92A7	1A66212-505	025
LOX Mass Probe	406A1	1A48430-509	D9
LH_2 Mass Probe	408A1	1A48431-501	D4
LOX Overilll Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511.1	D128
LOX Fastfill Sensor	406A2C5	1A68710-1	D90
LOX Fastfill Control Unit	404A72A5	1A68710-511.1	C16
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	D116
LH_2 Fastfill Sensor	408A2C5	1A68710-1	D89
LH_2 Fastfill Control Unit	411A92A43	1A68710-509	D121

Initial conditions for the test were established on 6 November 1968; and the ratio values, obtained from the manual PU system calibration procedure, H&CO 1B64367, were loaded into the computer. From these ratio values, nominal test values were computed for the LOX and LH_2 coarse mass voltages, fine mass voltages, and loading voltages. After an evaluation of the computer printout, a test of the PU system power was made. Power was applied to the PU inverter-converter, and the forward bus 2 voltage was measured. After a programmed

4.4.18 (Continued)

delay of 15 minutes to allow the inverter-converter to stabilize, the output voltage and frequency were measured and determined to be within specified limits. An additional delay of 30 minutes was required for the PU oven temperature to stabilize. Verification was made that the oven temperature was within the tolerance range.

The servo bridge balance and ratio valve null tests were conducted next. The error voltages, as well as the LOX and LH_2 coarse and fine voltages, were measured and determined to be within design specifications and tolerance limits.

The PU loading test was accomplished next. The PU boiloff bias on indication was verified to be off, and the LH_2 boiloff bias voltage was measured as 0.60 vdc. With the PU boiloff bias on indication on, the PU boiloff bias was measured as 8.28 vdc. The PU boiloff bias was then turned off, and the bias voltage was determined to be 0.46 vdc.

The GSE power supply voltage was measured as 29.118 vdc. The LOX and LH_2 loading potentiometer sense voltages were measured, and the LOX and LH_2 loading potentiometer signal voltages were measured. The LOX and LH_2 1/3 checkout relay commands were turned on, and the LOX and LH_2 loading potentiometer signal voltages were again measured. The checkout relay commands were turned off, and the LOX and LH_2 loading potentiometer sense voltages were again measured.

The servo balance bridge gain test was conducted next, starting with a measurement of the error signal voltage and the ratio valve position in degrees. The LOX and LH_2 coarse and fine mass voltages were measured initially and were

4.4.18 (Continued)

remeasured with the 1/3 and 2/3 checkout relay commands turned on. In reverse order, the voltages were measured as the 2/3 and 1/3 checkout relay commands were turned off. All measurements were within the required limits as determined by the ACS.

The next test checked operation of the overfill and fastfill sensors in the LOX and LH_2 tanks. This test was accomplished by verification that the proper indications were registered under ambient (dry) and under simulated wet conditions of the sensors.

For a PU valve movement test, 50 second plus valve slew checks and 50 second minus valve slew checks were conducted. The ratio valve position and the system test valve position signal were measured before each of the slew checks was started. During each slew, the ratio valve position was measured through the AO telemetry multiplexer at 3, 5, 8, 20, and 50 seconds after the slew started to determine the change in the position from the preslew measurement. As shown in the Test Data Table, all of the measurements were within the required limits.

The PU activate test was conducted next with the measurements made through the AO and BO multiplexer circuits. The ratio valve position was measured, the LOX bridge 1/3 checkout relay command was turned on, and the LOX coarse mass voltage was measured. The ratio valve position was remeasured with the PU activate switch turned on, then turned off. The LOX bridge 1/3 checkout relay command was turned off, and all voltages were remeasured. The test was then repeated using the LH_2 bridge 1/3 checkout relay command and measuring the LH_2 coarse mass voltage.

4.4.18 (Continued)

For a final test, the PU valve hardover position command was turned on; and the PU system ratio valve position was measured as -27.192 degrees with the LOX bridge 1/3 checkout relay command and the PU activate switch both on, meeting the requirement of -20 degrees maximum.

Engineering comments indicated that no interim use material items were installed, and there were no part shortages at the start of this test. No FARR's were written as a result of this test, and the PU system was accepted for use on 7 November 1968.

4.4.18.1 Test Data Table, Propellant Utilization System

Loaded Ratio Values (from H&CO 1B64367)

LOX Empty Ratio	0.021	LH_2 Empty Ratio	0.000
LOX 1/3 Bridge Slew Ratio	0.285	LH_2 1/3 Bridge Slew Ratio	0.310
LOX 2/3 Bridge Slew Ratio	0.574	LH_2 2/3 Bridge Slew Ratio	0.640
LOX Wiper Ratio	0.042	LH_2 Wiper Ratio	0.014

LH_2 Boiloff Bias Voltage (vdc) 7.221

Computed Coarse Mass Voltages (vdc)

LOX Empty	0.103	LH_2 Empty	0.000
LOX 1/3 Mass	1.426	LH_2 1/3 Mass	1.548
LOX 2/3 Mass	2.871	LH_2 2/3 Mass	3.198

Computed Fine Mass Voltages (vdc)

LOX Empty	4.009	LH_2 Empty	1.367
LOX 1/3 Mass	0.054	LH_2 1/3 Mass	2.339
LOX 2/3 Mass	1.729	LH_2 2/3 Mass	4.683

Computer Loading Voltages (vdc)

LOX Empty	0.574	LH_2 Empty	0.000
LOX 1/3 Coarse Mass	7.984	LH_2 1/3 Coarse Mass	8.668

4.4.18.1 (Continued)

PU System Power Test

Function	Measured Value	Limits
Forward Bus 2 Voltage (vdc)	28.278	28.0 ± 2
Inv-Conv 115 vrms Output (vac)	114.506	115.0 ± 3.4
Inv-Conv 21 vdc Output (vdc)	21.292	21.25 ± 1.25
Inv-Conv 5 vdc Output (vdc)	4.975	4.8 ± 0.3
Inv-Conv Frequency (Hz)	400.477	400.0 ± 6

Bridge Balance and Ratio Valve Null Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.351			0.000 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.117	0.103	0.103 ± 0.1
LOX Fine Mass Voltage (vdc)		4.033	4.019	4.009 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0.000	0.000	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.382	1.382	1.367 ± 0.4

PU Loading Test

Function	Measured Value	Limits
LH_2 Boiloff Bias Signal Volt. (vdc)	8.28	7.221 ± 2.0
GSE Power Supply Voltage (vdc)	29.118	28.0 ± 2.0

Loading Potentiometer Function	LOX Value	LH_2 Value	Limits
Sense Voltage, GSE Power On (vdc)	29.079	28.999	GSE Pwr ± 0.4
Signal Voltage, Relay Commands	0.520		0.574 ± 0.5
Off (vdc)		0.000	0.0 ± 0.5
Signal Voltage, Relay Commands	7.766		7.984 ± 0.6
On (vdc)		8.504	8.668 ± 0.6
Signal Voltage, Relay Commands	0.656		0.574 ± 0.5
Off (vdc)		0.027	0.0 ± 0.5
Sense Voltage, GSE Power OFF (vdc)	-0.039	0.000	0.0 ± 0.75

Servo Balance Bridge Gain Test

Function	Measured Value	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.282			0.351 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.093	0.103	0.103 ± 0.1
LOX Fine Mass Voltage (vdc)		4.004	4.004	4.009 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0.000	0.000	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.367	1.362	1.367 ± 0.4

4.4.18.1 (Continued)

Function	Measured Value	AO Multi	BO Multi	Limits
1/3 Checkout Relay Commands On				
Ratio Valve Position (deg)	0.761			0.351 ± 1.5
LOX Coarse Mass Voltage (vdc)		1.421	1.426	1.426 ± 0.1
LOX Fine Mass Voltage (vdc)		0.020	0.015	0.054 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		1.548	1.548	1.548 ± 0.1
LH_2 Fine Mass Voltage (vdc)		2.510	2.505	2.339 ± 0.4
2/3 Checkout Relay Commands On				
Ratio Valve Position (deg)	1.306			0.351 ± 1.5
LOX Coarse Mass Voltage (vdc)		2.871	2.871	2.871 ± 0.1
LOX Fine Mass Voltage (vdc)		1.494	1.499	1.729 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		3.208	3.198	3.198 ± 0.1
LH_2 Fine Mass Voltage (vdc)		5.000	4.971	4.683 ± 0.4
2/3 Checkout Relay Commands Off				
Ratio Valve Position (deg)	0.828			0.351 ± 1.5
LOX Coarse Mass Voltage (vdc)		1.416	1.412	1.426 ± 0.1
LOX Fine Mass Voltage (vdc)		0.015	0.010	0.054 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		1.548	1.543	1.548 ± 0.1
LH_2 Fine Mass Voltage (vdc)		2.505	2.505	2.339 ± 0.4
1/3 Checkout Relay Commands Off				
Ratio Valve Position (deg)	0.282			0.351 ± 1.5
LOX Coarse Mass Voltage (vdc)		0.103	0.103	0.103 ± 0.1
LOX Fine Mass Voltage (vdc)		4.014	3.999	4.009 ± 0.4
LH_2 Coarse Mass Voltage (vdc)		0.000	0.000	0.000 ± 0.1
LH_2 Fine Mass Voltage (vdc)		1.367	1.362	1.367 ± 0.4

PU Valve Movement Test

Function	Measured Value	Limits
Ratio Valve Position, AO (deg)	0.351	0.351 ± 1.50
Ratio Valve Position, BO (deg)	0.419	0.351 ± 1.50

4.4.18.1 (Continued)

Function	Measured Value	Limits
50 Second Plus Valve Slew, AO Multiplexer		
+1 vdc System Test Valve Position Signal (vdc)	1.001	1.00 ± 0.36
V1, Position at T+3 Seconds (deg)	4.228	2.037 to 6.351
V2, Position at T+5 Seconds (deg)	5.182	2.659 to 7.396
V3, Position at T+8 Seconds (deg)	5.728	2.977 to 7.396
V4, Position at T+20 Seconds (deg)	6.000	5.226 to 7.396
V5, Position at T+50 Seconds (deg)	6.000	5.226 to 7.396
50 Second Minus Valve Slew, AO Multiplexer		
Ratio Valve Position, AO (deg)	0.42	0.419 ± 0.150
-1 vdc System Test Valve Error Signal (vdc)	-0.995	-1.000 ± 0.036
V1, Position at T+3 Seconds (deg)	-3.816	-2.037 to -6.351
V2, Position at T+5 Seconds (deg)	-4.703	-2.659 to -7.396
V3, Position at T+8 Seconds (deg)	-5.249	-2.977 to -7.396
V4, Position at T+20 Seconds (deg)	-5.521	-5.226 to -7.396
V5, Position at T+50 Seconds (deg)	-5.521	-5.226 to -7.396

PU Activation Test

Function	AO Multi	BO Multi	Limits
Ratio Valve Position (deg)	0.351	0.282	0.351 ± 1.50
LOX 1/3 Command Relay On			
LOX Coarse Mass Voltage (vdc)	1.415	1.421	1.426 ± 0.1
PU System On			
Ratio Valve Position (deg)	33.280	33.213	20.0 min
PU System Off			
Ratio Valve Position (deg)	0.761	0.761	15.0 max
LOX 1/3 Command Relay Off			
LOX Coarse Mass Voltage (vdc)	0.103	0.103	0.103 ± 0.1
Ratio Valve Position (deg)	0.351	0.419	0.351 ± 1.5
LH_2 1/3 Command Relay On			
LH_2 Coarse Mass Voltage (vdc)	1.538	1.548	1.548 ± 0.1
PU System On			
Ratio Valve Position (deg)	-27.123	-27.123	-20.0 max
PU System Off			
Ratio Valve Position (deg)	0.49	--	-15.0 min
LH_2 1/3 Command Relay Off			
LH_2 Coarse Mass Voltage (vdc)	0.000	0.000	0.000 ± 0.1
Ratio Valve Position (deg)	0.215	0.282	0.351 ± 1.5

4.4.19 <u>Hydraulic System (1B55824 G)</u>

This automatic procedure verified the integrity of the stage hydraulic system and demonstrated the capability of the system to provide engine centering and control during powered flight. The test involved all components of the stage hydraulic system, including the main hydraulic pump, P/N 1A66240-503, S/N 457808; the auxiliary hydraulic pump, P/N 1A66241-511, S/N X454588; the accumulator/reservoir assembly, P/N 1B29319-519, S/N 34; the hydraulic pitch actuator, P/N 1A66248-505-011, S/N 51; and the hydraulic yaw actuator, P/N 1A66248-505-011, S/N 53.

The procedure was satisfactorily accomplished by the first attempt on 7 November 1968, and was accepted on the same date. Those function values measured during the test are presented in Test Data Table 4.4.19.1. All of these values were acceptable and were within general design requirements, although specific limit requirements were not defined in the procedure for most of the measurements.

The stage power setup, H&CO 1B55813, was accomplished; and initial conditions were established for the test. The instrument unit (IU) substitute 5 volt power supply was turned on and its voltage measured, and the aft 5 volt excitation module voltage was measured. Measurements were made of various hydraulic system functions with the hydraulic system unpressurized. Measurements were also made to determine the accumulator/reservoir gaseous nitrogen mass and corrected oil level.

4.4.19 (Continued)

The methods of controlling the auxiliary hydraulic pump were checked next. After verifying that a power cable was connected to the auxiliary hydraulic pump motor, the aft bus 2 power supply was turned on, and the bus voltage was verified to be 56.0 ±4.0 vdc. The coast mode operation was checked by applying dry ice to the coast mode thermal switch and by verifying that the low temperature caused the thermal switch to turn the auxiliary pump on when the auxiliary hydraulic pump coast command was turned on. The dry ice was removed, and it was verified that the increased temperature caused the thermal switch to turn the pump off. The coast command and the aft bus 2 power supply were turned off, and the bus voltage was verified to be 0.0 ±1.0 vdc. During the remaining pump control checks, only the auxiliary hydraulic pump motor ON indication was checked, as the pump did not run while the aft bus 2 power was off. The flight mode operation was checked by verifying that turning the auxiliary hydraulic pump flight command on and off properly turned the auxiliary pump on and off. The manual mode operation was checked by verifying that the auxiliary pump could be properly turned on and off at the GSE mechanical systems panel when the GSE was in the manual mode.

The engine centering tests were then conducted. The first test was conducted with the actuator position locks on and with the hydraulic system unpressurized. The actuator positions and the voltage of the IU substitute 5 volt power supply and the aft 5 volt excitation module were measured; and the corrected actuator positions were determined. The pitch and yaw actuator locks were removed, the aft bus 2 power was turned on, and the voltage was measured. The auxiliary hydraulic pump was turned on in the automatic mode, and the aft bus

4.4.19 (Continued)

2 current was measured. The increase in hydraulic system pressure over a 4 second period was measured and determined to be within tolerance. With the hydraulic system pressurized and no excitation signal applied to the actuator, the second engine centering test was conducted with the actuator locks off. The test measurements were repeated as before, and the corrected actuator positions were again determined. A zero excitation signal was then applied to the actuators; the hydraulic system functions were measured; the actuator position measurements were repeated; and the corrected actuator positions were again determined.

A clearance, linearity, and polarity check was accomplished next. The actuators were individually extended to their stops, then retracted causing the engine to move out to its extremes of travel, 0 degrees to $\pm 7\frac{1}{2}$ degrees, in a square pattern, counterclockwise as viewed from the engine bell. The engine was then returned to its 0 degree centered position. As the engine was sequenced through the square pattern, a clearance check verified that there was no interference to engine motion within the gimbal envelope. A comparison of the hydraulic servo engine positioning system command and response signals verified that the response movement was of the correct polarity and magnitude to agree with the command signal and met the requirements for movement linearity. When the actuators were at their extremes and when they were returned to neutral, checks of the hydraulic system pressure and reservoir oil pressure verified that these pressures remained acceptable.

4.4.19 (Continued)

Transient response tests were conducted next. Step commands were separately applied to the pitch and yaw actuators causing each actuator to individually move the engine from 0 degrees to -3 degrees, from -3 degrees to 0 degrees, from 0 degrees to +3 degrees, and from +3 degrees to 0 degrees. The engine response was observed visually and audibly for unwanted oscillations, and the actuator responses were recorded during the engine movement. The engine slew rates were computed for each of the step movements. The test data table shows the computed slew rates and representative actuator response values for the initial period of each check. The values measured were all acceptable and within general design requirements, although specific limits were not discernible from the procedure.

After the transient response test was completed, final measurements were made of the hydraulic system functions and the engine centering functions with the hydraulic system pressurized; the actuator locks off; and no excitation signals applied to the actuators.

The procedure was completed by turning off the auxiliary hydraulic pump, aft bus 2, and the IU substitute 5 volt power supply. The pitch and yaw actuator locks were then replaced.

Engineering comments noted that all parts were installed during this test. No major problems were encountered during the test. Four revisions were made to the procedure for the following:

a. One revision authorized a program change that would prevent the hydraulic pump from unexpectedly turning on if the thermal switch should pickup after a malfunction.

4.4.19 (Continued)

b. One revision was required to correct an error in the program.

c. One revision listed the information that was not printed out due to a typewriter malfunction.

d. One revision attributed the aft bus 2 voltage out-of-tolerance condition to an insufficient time delay between power turnoff and bus voltage measurements.

4.4.19.1 Test Data Table, Hydraulic System

Function	Measurement	Limits
IU Substitute 5 Volt Power Supply (vdc)	5.01	5.00 ± 0.05
Aft 5 Volt Excitation Module (vdc)	5.00	5.00 ± 0.05
Hydraulic System Unpressurized		
Reservoir Oil Pressure (psia)	82.48	*
Accumulator GN_2 Pressure (psia)	2321.00	*
Accumulator GN_2 Temperature (°F)	60.80	*
Reservoir Oil Level (%)	91.72	*
Pump Inlet Oil Temperature (°F)	65.49	*
Reservoir Oil Temperature (°F)	65.49	*
Aft Bus 2 Current (amp)	0.00	*
Gaseous Nitrogen Mass (lb)	1.928	1.925 ± 0.2
Corrected Reservoir Oil Level (%)	102.6	95.0 min
Engine Centering Test, Locks On, System Unpressurized		
T/M Pitch Actuator Position (deg)	-0.03	*
IU Pitch Actuator Position (deg)	-0.01	*
T/M Yaw Actuator Position (deg)	0.01	*
IU Yaw Actuator Position (deg)	0.06	*
IU Substitute 5 Volt Power Supply (vdc)	5.01	*
Aft 5 Volt Excitation Module (vdc)	5.00	*
Pitch Actuator Signal (ma)	0.00	*
Yaw Actuator Signal (ma)	0.05	*
Corrected T/M Pitch Actuator Position (deg)	-0.025	-0.236 to 0.236
Corrected IU Pitch Actuator Position (deg)	0.000	-0.236 to 0.236
Corrected T/M Yaw Actuator Position (deg)	0.006	-0.236 to 0.236
Corrected IU Yaw Actuator Position (deg)	0.046	-0.236 to 0.236
Aft Bus 2 Voltage (vdc)	56.24	56.0 ± 4.0
Aft Bus 2 Current (amp)	60.20	55.0 ± 30.0
Hyd System 4 Second Press Change (psia)	297.9	200.0 min

*Limits Not Specified

4.4.19.1 (Continued)

Function	Measurement	Limits
Engine Centering Test, Locks Off, System Pressurized No Excitation Signal		
T/M Pitch Actuator Position (deg)	-0.06	*
IU Pitch Actuator Position (deg)	-0.04	*
T/M Yaw Actuator Position (deg)	0.03	*
IU Yaw Actuator Position (deg)	0.08	*
IU Substitute 5 Volt Power Supply (vdc)	4.99	*
Aft 5 Volt Excitation Module (vdc)	5.00	*
Pitch Actuator Signal (ma)	0.00	*
Yaw Actuator Signal (ma)	0.10	*
Hydraulic System Pressurized, Locks Off, Zero Excitation Signal Applied to Actuators		
Hydraulic System Pressure (psia)	3617.69	*
Reservoir Oil Pressure (psia)	174.14	*
Accumulator GN_2 Pressure (psia)	3605.75	*
Accumulator GN_2 Temperature (°F)	79.19	*
Reservoir Oil Level (%)	39.31	*
Pump Inlet Oil Temperature (°F)	75.67	*
Reservoir Oil Temperature (°F)	74.49	*
Aft Bus 2 Current (amp)	43.20	*
T/M Pitch Actuator Position (deg)	-0.05	*
IU Pitch Actuator Position (deg)	-0.03	*
T/M Yaw Actuator Position (deg)	0.04	*
IU Yaw Actuator Position (deg)	0.08	*
IU Substitute 5 Volt Power Supply (vdc)	5.01	*
Aft 5 Volt Excitation Module (vdc)	5.00	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	0.10	*
Corrected T/M Pitch Actuator Position (deg)	-0.049	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0.015	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	0.045	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	0.061	-0.517 to 0.517

Transient Response Tests, Pitch Axis

Time From Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
Pitch 0 to -3 Degree Step Response - Engine Slew Rate: 17.0 deg/sec			
0.000	0.000	-0.118	5.005
0.149	-19.775	-2.597	5.005
0.278	-19.775	-3.116	5.000
0.147	-19.775	-3.174	5.005

*Limits Not Specified

4.4.19.1 (Continued)

Time From Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
0.556	-19.775	-3.174	5.005
0.693	-19.775	-3.203	5.005
0.925	-19.775	-3.203	5.000
1.183	-19.775	-3.188	5.005
1.460	-19.775	-3.217	5.005
1.736	-19.775	-3.188	5.005
Pitch -3 to 0 Degree Step Response - Engine Slew Rate: 16.9 deg/sec			
0.000	-19.750	-3.206	5.005
0.134	0.049	-0.952	5.005
0.280	0.000	-0.115	5.005
0.410	0.000	-0.086	5.005
0.549	0.000	-0.058	5.000
0.687	0.000	-0.071	5.005
0.908	0.049	-0.071	4.990
1.186	0.049	-0.058	5.005
1.463	0.000	-0.058	5.000
1.738	0.049	-0.071	5.010
Pitch 0 to +3 Degree Step Response - Engine Slew Rate: 16.6 deg/sec			
0.000	0.000	-0.044	5.005
0.162	19.873	2.612	5.000
0.272	19.873	3.017	5.005
0.411	19.824	3.030	5.005
0.549	19.873	3.146	5.010
0.688	19.873	3.074	5.005
0.909	19.873	3.132	5.005
1.186	19.824	3.103	5.010
1.370	19.873	3.132	5.005
1.646	19.873	3.117	5.005
Pitch +3 to 0 Degree Step Response - Engine Slew Rate: 17.3 deg/sec			
0.000	19.899	3.103	5.005
0.137	0.000	0.736	5.005
0.274	0.000	0.029	5.005
0.414	0.000	-0.028	5.005
0.552	0.000	-0.058	5.005
0.689	0.000	-0.058	5.005
0.921	0.049	-0.071	5.010
1.180	0.049	-0.058	5.005
1.475	0.000	-0.058	5.005
1.732	0.000	-0.058	5.005

4.4.19.1 (Continued)

Transient Response Tests, Yaw Axis

Time From Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
Yaw 0 to -3 Degree Step Response - Engine Slew Rate: 15.3 deg/sec			
0.000	0.050	-0.044	4.999
0.140	-19.727	-2.266	5.005
0.415	-19.727	-2.958	5.000
0.545	-19.727	-3.017	5.005
0.683	-19.727	-3.002	5.000
0.923	-19.727	-2.987	5.005
1.181	-19.727	-3.002	5.005
1.401	-19.727	-3.002	5.005
1.733	-19.727	-3.002	5.005
Yaw -3 to 0 Degree Step Response - Engine Slew Rate: 16.1 deg/sec			
0.000	-19.699	-2.997	5.005
0.131	0.098	-0.909	5.005
0.278	0.049	-0.059	5.000
0.407	0.049	0.000	5.005
0.546	0.049	0.043	5.005
0.684	0.049	0.043	5.005
0.923	0.049	0.058	5.005
1.181	0.098	0.058	5.005
1.458	0.049	0.058	4.990
1.734	0.049	0.058	5.005
Yaw 0 to +3 Degree Step Response - Engine Slew Rate: 15.6 deg/sec			
0.000	0.100	0.075	4.999
0.137	19.922	2.192	5.000
0.274	19.824	2.957	5.005
0.414	19.922	3.016	5.005
0.542	19.873	3.029	5.000
0.689	19.922	3.059	5.005
0.920	19.222	3.059	5.005
1.178	19.922	3.059	5.010
1.418	19.922	3.087	5.005
1.730	19.873	3.059	5.005

4.4.19.1 (Continued)

Time From Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
Yaw +3 to 0 Degree Step Response - Engine Slew Rate: 14.9 deg/sec			
0.000	19.949	3.089	5.005
0.138	0.049	0.923	5.005
0.275	0.049	0.101	5.000
0.414	0.049	0.058	5.000
0.543	0.049	0.058	5.005
0.682	0.049	0.043	4.990
0.920	0.049	0.058	5.005
1.180	0.049	0.058	5.000
1.474	0.049	0.028	5.000
1.743	0.049	0.043	5.000

Final Hydraulic System and Engine Centering Test
System Pressurized, Locks Off, No Excitation Signal

Function	Measurement	
Hydraulic System Pressure (psia)	3627.56	*
Reservoir Oil Pressure (psia)	178.93	*
Accumulator GN_2 Pressure (psia)	3630.31	*
Accumulator GN_2 Temperature (^{o}F)	71.36	*
Reservoir Oil Level (%)	42.31	*
Pump Inlet Oil Temperature (^{o}F)	136.69	*
Reservoir Oil Temperature (^{o}F)	120.09	*
Aft Bus 2 Current (amps)	44.80	*
T/M Pitch Actuator Position (deg)	-0.08	*
IU Pitch Actuator Position (deg)	-0.06	*
T/M Yaw Actuator Position (deg)	0.01	*
IU Yaw Actuator Position (deg)	0.05	*
IU Substitute 5 Volt Power Supply (vdc)	5.01	*
Aft 5 Volt Excitation Module (vdc)	5.00	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	0.10	*
Corrected T/M Pitch Actuator Position (deg)	-0.072	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0.044	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	0.006	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	0.031	-0.517 to 0.517

*Limits Not Specified

4.4.20 Telemetry and Range Safety Antenna System Check (1B64679 F)

This test procedure verified the integrity of the telemetry and range safety antenna systems by determining that the VSWR's and insertion losses were within the required limits.

Initiated on 7 November 1968, the checkout was completed on 21 November 1968. The tests in this procedure were performed by disconnecting various transmission lines in the telemetry system and determining VSWR's and insertion losses for various segments of the system. Measurements of the telemetry system components were made at 258.5 ±0.1 MHz.

A test cable, P/N 1B50922-1, was calibrated for use in the procedure and was found to have a VSWR of 9.5 at 258.5 MHz. The telemetry system insertion loss was measured at the PCM transmitter output, with a 50 ohm load replacing the antenna not under test. The loss to antenna 1 was 6.3 db, and the loss to antenna 2 was 6.1 db, both within the 6.7 db maximum loss limit.

The VSWR of the closed loop telemetry system, from the PCM transmitter through the dummy load, was measured as 1.11, meeting the requirement of 1.5 maximum VSWR. The VSWR of the open loop telemetry system, from the transmitter through the antennas, was measured as 1.06, meeting the 1.7 maximum VSWR requirement.

There were no FARR's written as a result of this procedure. Three revisions were made for the following:

a. One revision authorized the use of substitute test equipment.

b. One revision reperformed the telemetry system insertion loss. The first readings were out-of-tolerance due to inaccurate setting of the signal generator frequency.

c. One revision deleted all sections except the telemetry system VSWR checks, as the range safety system checkout was not required.

4.4.21 Propulsion System Test (1B62753 K)

This automatic procedure performed the postmodification integrated electromechanical functional tests required to verify the operational capability of the stage propulsion system. For convenience of performance, the test sequences were divided into three sections: The first section checked the ambient helium system and included functional checks of the pneumatic control system and the propellant tanks repressurization system; the second test section checked the propellant tanks pressurization system; and the third section was a four part functional check of the J-2 engine system. The first segment of the J-2 engine checkout tested the spark ignition systems for the J-2 engine thrust chamber and gas generator, the second segment functionally checked the engine cutoff logic and delay timers, the third segment checked the J-2 engine valve sequencing with control helium pressurization, and the final segment was a combined automatic check of the J-2 engine system operation.

The postmodification propulsion system testing was initiated on 9 November 1968. Acceptance of the propulsion system was on 12 November 1968.

Subsequent to establishing initial conditions, testing of the ambient helium system commenced by pressurizing the ambient helium pneumatic control sphere and repressurization spheres to 700 ± 50 psia and setting the stage control helium regulator discharge pressure at 515 ± 50 psia. A series of checks verified the proper operation of the control helium dump valve and the pneumatic power control module shutoff valve. After verifying the proper operation of the LOX chilldown pump purge control and dump valves, the LOX chilldown pump purge pressure switch checkout was conducted.

4.4.21 (Continued)

The LH_2 and LOX repressurization control module dump valves and control valves were verified to operate properly. A series of checks verified the proper functioning of the O_2H_2 burner spark system and propellant valves.

A three-cycle test of the engine pump purge pressure switch preceded the functional checkout of the engine pump purge valve. The control helium regulator backup pressure switch and the control helium shutoff valve were similarly tested. The control helium sphere was pressurized to 734.76 psia; and the control helium regulator discharge pressure was measured at 563.14 psia, both within acceptable limits. A series of checks verified the operation of the pneumatically controlled valves, including the LH_2 and LOX vent valves, fill and drain valves, prevalves, chilldown shutoff valves, the LH_2 directional vent valve, the LH_2 continuous vent and relief override valve and orificed bypass valve, and the O_2H_2 burner propellant valves and LOX shutdown valve. The LH_2 tank pressurization and continuous vent valve blowdown check completed the ambient helium system test.

Section two, the propellant tanks pressurization systems test, was started with functional checks of the cold helium dump and shutoff valves. The operation of the cold helium regulator backup pressure switch was verified by the three-cycle pressure switch test, as well as by verifying that the switch properly controlled the cold helium shutoff valve.

The LOX and LH_2 repressurization control valves were verified to operate properly, and the operation of the LOX and LH_2 tank repressurization backup pressure

4.4.21 (Continued)

switch interlocks was verified by the three-cycle test and by demonstrating that the switches properly controlled the LOX and LH_2 repressurization control valves.

The proper operation of the O_2H_2 burner spark ignition system was verified. The LOX tank pressure switches, the cold helium shutoff valve, and the cold helium heat exchanger bypass valve were verified to operate properly. Proper control of the LOX main fill valve, the LOX auxiliary tank pressurization valve, the LOX replenish valve, and the LOX repressurization valve by the pressure switches was demonstrated.

The LH_2 repressurization and ground fill overpressurization pressure switches were verified to operate properly. Control of the LH_2 main fill valve, the LH_2 replenish valve, the LH_2 auxiliary tank pressure valve, the step pressure valve, and the repressurization control valve by the pressure switches was also demonstrated. After satisfactory completion of the LH_2 pressure switch checks, the cold helium system was pressurized to 896.45 psia; and the cold helium sphere blowdown and cold helium regulator low flow test were conducted. The cold helium spheres were vented, and a series of checks verified proper operation for the O_2H_2 burner voting circuit and burner malfunction temperature sensors. This completed testing of the propellant tanks pressurization systems.

Section three, the J-2 engine functional tests, was conducted next. The LH_2 and LOX tanks were vented to ambient, the O_2H_2 burner spark systems 1 and 2, the emergency detection systems 1 and 2 engine cutoffs, the repressurization control valves, and the O_2H_2 burner propellant valves were verified to operate properly.

4.4.21 (Continued)

The engine spark test verified proper operation of the thrust chamber augmented spark igniter (ASI) and gas generator spark systems. The engine start tank was pressurized, the proper operation of the start tank vent valve was verified, and the start tank was vented to ambient pressure prior to the engine cutoff test. The engine ready signal was verified to be on, and the simulated mainstage OK signal opened the prevalves. Verification of proper prevalve response to the switch selector engine cutoff signals was made with the prevalves closing to the cutoff signal and opening at signal removal. The engine ignition cutoff test and the LH_2 injector temperature detector bypass test were satisfactorily conducted.

The next series of tests verified that the simulated aft separation signals, 1 and 2, individually inhibited engine start and demonstrated proper operation of the LH_2 injector temperature detector bypass and start tank discharge control. During these tests, measurements were made of the helium delay timer, the sparks de-energized timer, and the start tank discharge timer.

Three-cycle tests of mainstage OK pressure switches 1 and 2 were conducted. It was verified that the pickup of either switch turned off the engine thrust OK 1 and 2 indications and that after a dry engine start sequence, pickup of either switch would maintain the engine in mainstage. It was also demonstrated that dropout of both pressure switches was required to turn on engine thrust OK indications and cause engine cutoff.

4.4.21 (Continued)

The engine helium control sphere was pressurized to 1461.43 psia to conduct the engine valve sequence tests which demonstrated that actuation and deactuation of the helium control solenoid valve caused the LH_2 and LOX bleed valves to close and open, that opening and closing the ignition phase control solenoid valve caused the engine augmented spark igniter (ASI) LOX valve and engine main fuel valve to open and close, that the start tank discharge solenoid valve caused the engine augmented spark igniter (ASI) LOX valve and engine main fuel valve to open and close, that the start tank discharge solenoid valve opened and closed, and that opening and closing the mainstage control solenoid valve caused the gas generator valve and main LOX valve to open and close and the LOX turbine bypass valve to close and open.

The final test was the combined automatic functional demonstration of the entire J-2 engine system. The necessary commands were given to initiate engine start and cutoff; and throughout the automatic sequence, the engine system responses were verified to be within the predetermined limits.

There were no parts shortages affecting propulsion automatic testing and no test discrepancies resulting in the initiation of FARR's.

Seventeen revisions were made to the procedure as follows:

a. Three revisions concerned changes needed to correct the procedure, the test requirement drawing, and program errors.

b. One revision authorized opening the LOX chilldown pump purge hand valve to provide a slight flow through the pneumatic power control module when the stage control sphere was pressurized.

4.4.21 (Continued)

c. One revision outlined a functional test for the LH_2 continuous vent relief setting.

d. One revision gave instructions to perform the checkout of the start tank emergency vent system.

e. One revision added a checkout for NASA measurement numbers K001, K002, and K155. These parameters were insufficiently checked during the DDAS test, as the systems were at ambient.

f. One revision attributed the type messages "LH_2 flight pressure switch pickup did not close LH_2 first burn bypass control valve," and "LH_2 prepressure pressure switch pickup did not close the step pressure valve," to two leaks in the LH_2 tank pressure switch pneumatic circuit. After repair of the leaks, a second test was satisfactorily completed.

g. Two revisions concerned functional testing of the start tank vent and the helium control solenoid for orbital and translunar safing.

h. One revision attributed a malfunction indication of the LOX fill and drain valve to a test gauge being attached to the opening line of the valve. A retest, subsequent to removal of the gauge, was acceptable.

i. One revision attributed four malfunction printouts to momentary dual state talkback indications of GSE valves. Proper valve operation was verified, and the test was continued.

j. One revision initiated a backup to reperform the start tank vent valve functional test as the O_2H_2 burner spark test was recorded on the wrong oscillograph.

k. One revision stated that a malfunction of the start tank pressure was due to the start tank dump valve being left open as the result of a program backup. The dump valve was closed, and the tank was pressurized.

l. One revision authorized a manual reset of the stage 1 pressure to 1550 psia. The original setting of 1650 psia was too high.

4.4.21 (Continued)

m. One revision stated that the stage 2 supply pressure to stage 3 was set on the low side of the tolerance of 125 $\pm$25 psia causing the dome set to fault out in the time allotted. The program was continued satisfactorily.

n. One revision concerned changes to the J-2 sequence times to update the procedure.

4.4.21.1 Test Data Table, Propulsion Test

Section 1 - Ambient Helium Test

Function

Engine Pump Purge Pressure Switch Checkout

		Measured Values			
		Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	121.773	121.773	121.000	136.0 max
Dropout Pressure	(psia)	112.451	113.230	113.230	99.0 min
Deadband	(psid)	9.322	8.543	7.770	3.0 min

Control Helium Regulator Backup Pressure Switch Checkout

		Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	118.331	58.031	57.384	180.0 max
Pickup Pressure	(psia)	609.750	604.313	605.094	600 $\pm$ 21
Depressurization Time	(sec)	21.280	21.027	21.017	180.0 max
Dropout Pressure	(psia)	472.219	472.219	473.000	490 $\pm$ 31

Pneumatically Controlled Valve Timing Checkout

	Operating Times (sec)					
Valve	Open	Total Open	Close	Total Close	Boost Close	Total Boost Close
LH_2 Vent Valve	0.024	0.076	0.197	0.448	0.091	0.225
LOX Vent Valve	0.018	0.079	0.120	0.344	0.068	0.204
LOX F&D Valve	0.138	0.256	0.722	2.190	0.423	0.923
LH_2 F&D Valve	0.115	0.240	0.735	2.074	0.345	0.829
LOX Prevalve	1.200	1.848	0.148	0.282	*	*
LH_2 Prevalve	1.329	2.007	0.174	0.293	*	*
LOX C/D SOV	0.204	1.039	0.025	0.134	*	*
LH_2 C/D SOV	0.166	1.007	0.008	0.129	*	*

* Not applicable to these valves

4.4.21.1 (Continued

Section 1 - Ambient Helium Test (Continued)

Valve	Operating Times (sec) Open	Total Open	Close	Total Close	Boost Close	Total Boost Close
LH_2 Cont Vent Orif'd Bypass Valve	0.023	0.104	0.007	0.126	*	*
O_2H_2 Burner LH_2 Prop	0.030	0.108	0.038	0.118	*	*
O_2H_2 Burner LOX Prop	0.007	0.090	0.009	0.090	*	*
LH_2 Latch RLF Vlv	0.024	0.064	0.120	0.318	0.067	0.189
LOX NPV Vlv	0.029	0.054	0.150	0.369	0.080	0.214

Valve	Flight Position	Total Flt. Position	Ground Position	Total Ground Position
LH_2 Directional Vent Valve	0.071	0.189	0.876	1.449

Section 2 - Propellant Tanks Pressurization System Test

Function

Cold Helium Regulator Backup Pressure Switch Checkout

		Measured Values Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	59.003	70.953	71.430	180 max
Pickup Pressure	(psia)	466.00	466.00	460.00	467.5 ± 23.5
Depressurization Time	(sec)	25.271	25.156	25.146	180 max
Dropout Pressure	(psia)	368.102	368.102	368.875	362.5 ± 33.5

LOX Tank Repressurization Backup Pressure Switch Checkout

		Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	69.341	69.531	69.806	180 max
Pickup Pressure	(psia)	463.672	463.672	462.898	467.5 ± 23.5
Depressurization Time	(sec)	21.509	21.397	24.490	180 max
Dropout Pressure	(psia)	380.531	380.351	379.750	362.5 ± 33.5

LH_2 Tank Repressurization Backup Pressure Switch Checkout

		Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	79.182	79.438	78.158	180 max
Pickup Pressure	(psia)	477.648	478.438	476.102	467.5 ± 23.5
Depressurization Time	(sec)	24.653	24.592	24.567	180 max
Dropout Pressure	(psia)	378.969	378.195	378.195	362.5 ± 33.5

* Not applicable to these valves

4.4.21.1 (Continued)

Section 2 - Propellant Tanks Pressurization System Test (Continued)

Function

LOX Tank Ground Fill Overpressure Pressure Switch Checkout

		Measured Values			
		Test 1	Test 2	Test 3	Limits
Pressurization Time	(sec)	63.621	38.166	26.926	180 max
Pickup Pressure	(psia)	40.376	40.325	40.325	41 max
Depressurization Time	(sec)	9.500	7.349	6.713	180 max
Dropout Pressure	(psia)	39.054	39.105	39.105	27.8 min
Deadband	(psid)	1.322	1.220	1.220	0.5 min

LH_2 Repressurization Control Pressure Switch Checkout

Pressurization Time	(sec)	82.277	23.661	22.293	180 max
Pickup Pressure	(psia)	30.731	30.268	30.575	34 max
Depressurization Time	(sec)	31.101	32.887	33.515	180 max
Dropout Pressure	(psia)	28.653	28.602	28.602	27.8 min
Deadband	(psid)	2.078	2.026	1.974	0.5 min

LH_2 Tank Ground Fill Overpressure Pressure Switch Checkout

Pressurization Time	(sec)	80.222	27.746	19.967	180 max
Grd. Fill Overpress Pickup Press	(psia)	30.315	30.159	30.056	34 max
Depressurization Time	(sec)	67.583	56.509	68.604	180 max
Grd. Fill Overpress Dropout Pressure	(psia)	27.875	28.135	28.135	27.8 min
Deadband	(psid)	2.440	2.024	1.921	0.5 min

Section 3 - J-2 Engine Functional Test (Engine S/N J-2091)

Engine Delay Timer Checkout

Function	Delay Time (sec)	Limits (sec)
Ignition Phase Timer	0.451	0.450 ± 0.030
Helium Delay Timer	1.012	1.000 ± 0.110
Sparks De-energized Timer	3.287	3.300 ± 0.200
Start Tank Discharge Timer	0.996	1.000 ± 0.040

4.4.21 (Continued)

Section 3 - J2 Engine Functional Test (Continued)

Function

Mainstage OK Pressure Switch 1 Checkout

		Measured Values Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	536.63	532.09	532.86	515 ± 36
Dropout Pressure	(psia)	463.88	463.88	463.88	*
Deadband	(psid)	72.74	68.21	68.98	62.5 ± 48.5

Mainstage OK Pressure Switch 2 Checkout

		Test 1	Test 2	Test 3	Limits
Pickup Pressure	(psia)	514.95	511.07	511.84	515 ± 36
Dropout Pressure	(psia)	446.58	445.80	446.58	*
Deadband	(psid)	68.38	65.27	65.27	62.5 ± 48.5

Engine Sequence Check

Function	Start or Delay Time (sec)	Oper. or Travel Time (sec)	Total Time (sec)
Engine Start			
Cont He Solenoid Command Talkback	**	0.017	**
Ign Phase Cont Solenoid Command Talkback	**	0.011	**
ASI Valve Open	**	0.045	**
Engine LOX Bleed Valve Close	**	0.087	**
Engine LH_2 Bleed Valve Close	**	0.063	**
Main Fuel Valve Open	0.079	0.100	0.179
Start Tank Disch Timer	**	1.008	**
Start Tnk Disch Valve Open	0.091	0.081	0.172
Mainstage Cont Solenoid Energized	**	1.458	**
Ignition Phase Timer	**	0.450	**
Start Tnk Disch Cont Solenoid De-energized	**	0.007	**
Main LOX Valve Open	0.487	1.567	2.055
Start Tnk Disch Valve Close	0.215	0.109	0.324
Gas Generator Valve Open	**	0.145	0.242
LOX Turbine Bypass Valve Close	0.031	0.450	0.481
Spark System Off Timer	**	3.323	**

* Limits not specified

** Not applicable or not available

4.4.21.1 (Continued)

Section 3 - J-2 Engine Functional Test (Continued)

Engine Sequence Check (Continued)

Function	Start or Delay Time (sec)	Oper. or Travel Time (sec)	Total Time (sec)
Engine Cutoff			
Ign Phase Cont Solenoid De-energized from Cutoff	**	0.007	**
Mainstage Cont Solenoid De-energized from Cutoff	**	0.016	**
ASI Valve Close	0.037	**	**
Main LOX Valve Close	0.171	0.020	0.190
Main Fuel Valve Close	0.180	0.096	0.275
Gas Generator Valve Close	0.074	0.168	0.242
He Cont De-energized Timer	**	1.007	**
Engine LOX Bleed Valve Open	**	**	8.193
Engine LH_2 Bleed Valve Open	**	**	7.912
LOX Turbine Bypass Valve Open	0.326	0.451	0.777

Engine Sequence Data (Oscillograph Records)

Function	Measurements		Limits	
	Delay	Valve Motion	Delay	Valve Motion
Ignition (sec)				
Main Fuel Valve Open	0.040	0.078	0.030-0.090	0.030-0.130
Start Tank Disch Vlv Open	0.86	0.088	0.080-0.120	0.085-0.120
Mainstage (sec)				
GG Valve Fuel Open	0.081	0.034	*	*
GG Valve LOX Open	0.138	0.063	0.130-0.150	0.020-0.80
Start Tank Disch Valve Close	0.127	0.211	0.130±0.020	0.215±0.040
MOV 1st Stage Open	0.048	0.040	0.030-0.070	0.025-0.075
MOV 2nd Stage Open	0.583	1.674	0.054-0.680	1.750-1.900
Oxidizer Turbine Bypass Vlv Close	0.193	0.268	*	5.0 max

* Limits not specified

** Not applicable or not available

4.4.21.1 (Continued)

Engine Sequence Data (Oscillograph Records) (Continued)

Function	Measurements Delay	Measurements Valve Motion	Limits Delay	Limits Valve Motion
Cutoff (sec)				
Oxidizer Turbine Bypass Vlv Open	0.216	0.629	*	10.0 max
GG Valve LOX Close	0.055	0.027	0.040-0.100	0.010-0.055
Main Oxid Vlv Closed	0.056	0.123	0.045-0.075	0.105-0.135
Main Fuel Vlv Closed	0.074	0.233	0.065-0.115	0.200-0.250
Bleeds (sec)				
ASI Open	**	0.045	**	100 max
ASI Close	**	0.037	**	100 max
GG Valve LOX Open	**	8.193	**	30.0 max
GG Valve LOX Close	**	0.087	**	0.120 max
GG Valve Fuel Open	**	7.912	**	30.0 max
GG Valve Fuel Close	**	0.063	**	0.120 max
Timers (sec)				
Start Tnk Disch Vlv Decay	0.996	**	0.960-1.040	**
Ignition Phase	0.451	**	0.420-0.480	**
Sparks De-energize	3.287	**	3.10 -3.50	**
Helium Cont De-energize	1.012	**	0.890-1.110	**
Trace Deflections				
Oxid Turbine Bypass Valve 80% (sec)	0.504	**	0.350-0.550	**
Main Oxid Valve (deg)	14.1	**	12-16	**
GG Valve (%)	46	**	35-65	**

* Limits not specified

** Not applicable or not available

4.4.22 Digital Data Acquisition System (1B55817 M)

The digital data acquisition system (DDAS) test verified the operation of all data channels on the stage except certain data channels that were tested during specific system tests. The GSE D924A computer verified that the output of each channel tested was within the required tolerances. Proper operation was verified for the DDAS signal conditioning equipment and associated amplifiers, the remote automatic calibration system (RACS) and the associated command calibration channel decoder assemblies, and the telemetry transmitter and antenna system. The specific items involved in this test were:

Part Name	Ref. Location	P/N	S/N
PCM/DDAS Assembly	411A97A200	1B65792-1	6700092
CP1-BO Time Division Multiplexer	404A61A200	1B62513-547	013
DP1-BO Time Division Multiplexer	404A61A201	1B62513-543	014
Remote Digital Submultiplexer (RDSM)	404A60A200	1B52894-501	025
Remote Analog Submultiplexer (RASM)	404A60A201	1B66050-501	08
PCM RF Assembly	411A64A200	1B52721-521	011

This automatic procedure was initiated on 1 November 1968, and accepted on the third attempt on 20 November 1968. The first attempt was unsatisfactory as several parameters were not verified due to stage configuration. The second attempt was aborted for the same reason.

All channels were checked at ambient conditions, and those channels having a calibration capability were also checked under a RACS high or low mode calibration command. Ambient conditions were defined as 70°F at 14.7 psia, or for bi-level parameters, the normal state of valves or switches during the performance of this test. All channel outputs were measured and printed out.

4.4.22 (Continued)

The PCM RF test was conducted first. The forward and reflected RF output powers of the PCM/DDAS assembly were measured through the CP1-BO and the DP1-BO multiplexer telemetry outputs, and the voltage standing wave ratios (VSWR's) were determined. The same measurements were also made through the ground monitor outputs for both multiplexers. The CP1-BO multiplexer telemetry readings were: forward power, 25.221 watts; reflected power, 1.812 watts; VSWR, 2.128. The DP1-BO multiplexer telemetry readings were: forward power, 25.221 watts; reflected power, 1.843 watts; VSWR, 2.159. The CP1-BO multiplexer ground monitor readings were: forward power, 26.113 watts; reflected power, 1.063 watts; VSWR, 1.524. The DP1-BO multiplexer ground monitor readings were: forward power, 26.173 watts; reflected power, 1.059 watts; VSWR, 1.521.

All measurements were within the acceptable tolerances. High and low RACS tests were then conducted for the aft 5 volt excitation module voltage, while both the ground monitor and telemetry outputs were measured. High and low RACS for telemetry outputs were 3.994 vdc and -0.010 vdc, respectively, and 3.989 vdc (high) and -0.010 vdc (low) for the ground monitor.

The CP1-BO multiplexer was tested next, except for special channels. This test made measurements of high and low RACS voltages of each channel having calibration capability, and measurements of the ambient outputs in units of temperature, pressure, voltage, current, frequency, event indication, liquid level indication, and position indication, as applicable for the various channels. Output values for each of the CP1-BO multiplexer channels tested were within the required limits.

4.4.22 (Continued)

The DP1-BO multiplexer was then tested, except for special channels, in the same manner as described for the CP1-BO multiplexer, with no malfunctions. All channel outputs were within tolerance.

Special channel tests were conducted next. These special channels measured 400 Hz, 100 Hz, and 1500 Hz signals. The 400 Hz test checked the static inverter-converter frequency, the LOX and LH_2 chilldown inverter frequencies, and the LOX and LH_2 circulation pump flow rates. The LOX and LH_2 flowmeter tests at 100 Hz followed the 400 Hz test, and the LOX and LH_2 pump speeds were checked using the 1500 Hz signal. All of these special channels were within the required tolerance of the expected values.

An APS multiplexer test was then run to check the special channels on both multiplexers that measured the APS functions. Measurements were made of the high and low RACS voltages for each of the APS channels having calibration capabilities, and the ambient outputs were measured in ^{o}F or psia, as appropriate for the channel tested. All special channels were within the required tolerances.

The common bulkhead pressure and the LOX and LH_2 ullage pressures were verified to be within tolerances.

There were twenty revisions made to this procedure for the following:

a. Eight revisions were required to correct program errors.

b. Two revisions concerned corrections to the data description tape.

c. One revision authorized performance of the axial strain MUX test after setup of the signal conditioning system.

4.4.22 (Continued)

d. One revision deleted a step that was performed by a previous procedure.

e. One revision added the calculation of the expected battery temperature voltage value to the program. The values had been omitted from the procedure.

f. One revision set a breakpoint delay in the program to allow time for the GSE transducer power talkback to decay after the off command prior to measurement.

g. One revision added the RACS information for measurements C2037, C2035, C2044, C2042, C2043, and C0213.

h. One revision attributed the malfunction of the burner GH_2 injector pressure to a faulty transducer. The transducer was removed and replaced per FARR 500-489-332.

i. One revision stated that the malfunction indication of the LOX NPV 1 and 2 pressures was due to a pressure lockup in the NPV system. The pressure was vented, and the correct indications were received.

j. One revision accounted for the malfunction on channel DP1-BO-02-07. The transducer cable was disconnected at the time of the test. The cable was subsequently connected, and the value was within the expected tolerance.

k. One revision stated that the malfunctions on channels CP1-BO-23-09 and CP1-BO-23-10 were due to the atmospheric pressure being 14.65 psia. The program had been set for an expected pressure of 14.700 psia. After reprogramming to the existing pressure of 14.65 psia, no further malfunctions were noted.

l. One revision checked and compared the stage monitor panel common bulkhead pressure gauge to the bulkhead pressure transducers.

4.4.23 Range Safety Receiver Checks (1B55819 G)

This combined manual and automatic checkout verified the functional capabilities of the range safety receivers and decoders prior to their use in the range safety system. The receivers were checked for automatic gain control (AGC) calibration and drift, minimum acceptable deviation sensitivity, minimum acceptable RF sensitivity, and open loop RF operation. The items involved in this test were:

Item	Ref. Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	172
Range Safety Receiver 2	411A97A18	50M10697	195
Secure Command Decoder 1	411A99A1	50M10698	0124
Secure Command Decoder 2	411A99A2	50M10698	091

Initiated on 11 November 1968, this checkout was completed and accepted on 15 November 1968, after the fourth attempt. The first attempt was aborted due to a faulty micro dot generator. The second attempt was terminated after it was noted that the test code plugs were not installed on the decoder assemblies. Run three was invalidated by the replacement of the range safety system 2 receiver per FARR 500-489-383.

Several manual operations were accomplished before the automatic phase of the checkout was started. The total cable insertion loss values at the 450 MHz range safety frequency were determined to be 30.50 db for range safety system 1 and 31.00 db for range safety system 2. The destruct system test set, P/N 1A59952-1, was set up at 450 $\pm$0.045 MHz with a -17 dbm output level and a 60 $\pm$0.60 kHz deviation. The stage range safety antennas were disconnected from the directional power divider; and until the open loop RF checks, the 50 ohm loads were connected to the power divider for testing.

4.4.23 (Continued)

The cable insertion loss values were loaded into the computer, initial test conditions were established, the range safety receivers were transferred to external power and turned on, and the propellant dispersion cutoff command inhibit was turned on.

The receiver AGC calibration checks were conducted next. For each input signal level used in the calibration check, the computer determined the GSE test set output levels required to compensate for the cable insertion loss. Per the computer typeout, the GSE test set was manually adjusted to the appropriate output levels. The computer determined the input signal levels and measured the low level signal strength (AGC telemetry) of each receiver. These AGC measurements, in the 0.0 to 5.0 vdc range, were multiplied by a conversion factor of 20 and presented as per cent of full scale values. The difference in AGC values at each step was determined and utilized for the AGC drift check. As shown in Test Data Table 4.4.23.1, the AGC values were all acceptable; and the drift deviations were well below the 3 per cent of full scale maximum limit.

Manual -3 db and -60 db RF bandwidth checks were individually conducted on each receiver. With a GSE test set output frequency of 450.000 $\pm$0.005 MHz, the output level was adjusted to obtain a 2.0 $\pm$0.1 vdc AGC voltage from the receiver under test. The corresponding receiver RF output level was determined, and +20 dbm was added to obtain the RF reference level. The GSE test set output level was increased by 3 db, and the test set frequency was increased to greater than 450 MHz and decreased to less than 450 MHz until

4.4.23 (Continued)

the receiver AGC voltage was again 2.0 ±0.1 vdc. The frequencies at which this occurred were measured as the upper and lower -3 db bandedge frequencies. The -3 db bandwidth was found as the difference between these frequencies, and the bandwidth centering was found as the difference between the midpoint of these frequencies and 450 MHz. For the -60 db bandwidth check, this checkout was repeated, except that the test set output level was increased by 60 db in lieu of 3 db.

For the deviation threshold check, the GSE test set was adjusted to an output of 450 ±0.045 MHz at a level that provided receiver input levels of -63 dbm for receivers 1 and 2. A series of checks determined the minimum input deviation frequency at which each receiver responded to the respective range safety command. For each command, the GSE test set was manually adjusted to a sequence of deviation frequencies increasing from 5 kHz per the computer typeout. At each deviation frequency, the range safety secure command decoders were checked for the presence of the command signal from the appropriate receiver. As shown in the Test Data Table, the receivers responded to all commands at minimum deviation frequencies less than the 50 kHz maximum limit.

For the radio frequency sensitivity checks, the GSE test set was adjusted for an output of 450 ±0.045 MHz with a fixed deviation of 60 ±0.5 kHz. A series of checks determined the minimum input signal level at which each receiver responded to the respective range safety commands. For each command, the GSE test set output was manually adjusted to a sequence of levels increasing from -85.5 dbm, as requested by the computer. This gave input levels increasing

4.4.23 (Continued)

from -115.0 dbm for receivers 1 and 2. At each input level, the range safety secure command decoders were checked for receipt of the command signal from the appropriate receiver. Both receivers responded to minimum input levels less than the -93 dbm maximum limit.

The 50 ohm loads were disconnected from the stage power divider, and the range safety antennas were reconnected. For the manual open loop check, the GSE test set was adjusted for open loop operation, and the test set antenna coaxial switch was set to test position 1. The test set output level was set at -100 dbm and increased in 1 dbm increments until the AGC voltage of the least sensitive receiver no longer increased. This occurred at an output level of -78 dbm. The AGC voltage of the other receiver was verified to be at least 3 vdc at this level. The check was repeated with the test set antenna coaxial switch set to test position 2 with the output level measured as -77 dbm. The test set antenna coaxial switch was returned to the first test position, and the test set output level was set at -87.0 dbm for the automatic open loop RF checks.

Under open loop conditions, the low level signal strength (AGC telemetry voltage) of receiver 1 was 3.36 vdc while that of receiver 2 was 3.53 vdc. The range safety commands were transmitted from the GSE test set, and checks of the secure command decoders indicated the receivers responded properly to the open loop transmission. The PCM RF assembly power was turned on, the open loop PCM signal was verified to be received at the DDAS ground station, and the range safety commands were again transmitted. Checks of the decoders indicated that the receivers responded and were not adversely affected by the

4.4.23 (Continued)

PCM RF transmission. The PCM RF assembly power was turned off, and the range safety EBW firing units were transferred to external power. The propellant dispersion cutoff command inhibits were turned off for each receiver, and the range safety receivers were turned off, thus completing the range safety receiver checks.

Engineering comments noted that there were no part shortages affecting the test.

Six revisions were documented against the checkout:

a. Two revision concerned a NASA request to change the test set output from -63 dbm to -93 dbm.

b. One revision authorized a special range safety open loop test with the FM/FM transmitters turned on.

c. One revision authorized the performance of attempt two. The first attempt was aborted due to a faulty micro dot generator.

d. One revision concerned attempt three. Run two was terminated after it was noted that the test code plugs were not installed on the decoder assembly.

e. One revision stated that a fourth performance of the procedure was required to revalidate the range safety system after replacement of range safety 2 receiver per FARR 500-489-383.

4.4.23.1 Test Data Table, Range Safety Receiver Checks

AGC Calibration and Drift Checks (% = Per Cent of Full Scale)

Test Set Output (dbm)	Receiver 1 Input (dbm)	AGC 1 (%) Run 1	AGC 1 (%) Run 2	AGC 1 (%) Drift	Receiver 2 Input (dbm)	AGC 2 (%) Run 1	AGC 2 (%) Run 2	AGC 2 (%) Drift
-96.5	-127.0	18.05	17.42	0.63	-127.0	18.46	18.24	0.21
-89.5	-120.0	17.93	18.24	0.31	-120.0	18.46	18.87	0.41
-84.5	-115.0	18.34	18.34	0.00	-115.0	19.69	19.69	0.00
-79.5	-110.0	19.69	19.57	0.12	-110.0	22.97	23.07	0.10
-74.5	-105.0	23.28	22.97	0.31	-105.0	30.76	30.76	0.00
-69.5	-100.0	33.54	33.54	0.00	-100.0	49.84	49.43	0.41
-64.5	- 95.0	52.71	52.40	0.31	- 95.0	67.17	67.17	0.00
-59.5	- 90.0	68.01	68.40	0.21	- 90.0	71.27	71.17	0.10
-54.5	- 85.0	71.07	71.17	0.10	- 85.0	71.89	71.89	0.00
-49.5	- 80.0	71.58	71.58	0.00	- 80.0	72.19	72.09	0.10
-44.5	- 75.0	71.78	71.78	0.00	- 75.0	72.19	72.19	0.00
-39.5	- 70.0	71.89	71.99	0.10	- 70.0	72.09	72.09	0.00

-3 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC) (vdc)	2.00	2.00	2.0 ± 0.1
Reference RF Power Level (dbm)	-86.2	-87.7	-
Upper Band Edge Freq. (MHz)	450.153	450.154	-
Lower Band Edge Freq. (MHz)	449.830	449.839	-
-3 db Bandwidth (kHz)	323.0	315.0	340.0 ± 30.0
Bandwidth Centering (MHz)	449.997	449.997	450 ± 0.0338

-60 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC) (vdc)	2.00	2.00	2.0 ± 0.1
Reference RF Power Level (dbm)	-86.2	-87.7	-
Upper Band Edge Freq. (MHz)	450.499	450.702	-
Lower Band Edge Freq. (MHz)	449.523	449.524	-
-60 db Bandwidth (MHz)	0.976	1.164	1.2 max

Deviation Sensitivity Check

Range Safety Command	Minimum Deviation (kHz) Receiver 1	Minimum Deviation (kHz) Receiver 2
Arm and Engine Cutoff	15.0	12.5
Propellant Dispersion	15.0	12.5
Range Safety System Off	15.0	12.5

4.4.23.1 (Continued)

RF Sensitivity Check

Range Safety Command	Minimum Input Level (dbm) Receiver 1	Receiver 2
Arm and Engine Cutoff	-100.0	-105.5
Propellant Dispersion	-100.0	-105.5
Range Safety System Off	-100.0	-105.5

4.4.24 FM/FM and Single Sideband Telemetry System (1B73601 NC)

The purpose of this combined manual and automatic procedure was to verify the capability of the FM/FM and single sideband (SSB) telemetry system to properly transmit stage vibration and acoustical data. Stage hardware involved in the checkout included the vibration and acoustical instrumentation, the subcarrier oscillator (SCO) assembly, the model 245 multiplexer, the telemetry (T/M) calibrator, the RF multiplexer, the FM/FM (RF) transmitter, the SSB translator, the SSB wide band amplifier, and the SSB transmitter.

The manual test sequences were initiated on 11 November 1968, and continued on 12 November and 13 November, 1968. Automatic test sequences were initiated on 14 November 1968; however, the initial automatic attempt was aborted because of incomplete data received which was caused by disconnected electrical cabling, incomplete instrumentation installations, and GSE test equipment discrepancies. The second and final attempt for the automatic test sequences was conducted on 15 November 1968, completing the checkout of the FM/FM and SSB system at STC.

The checkout consisted of twenty tests, fourteen of which were manual sequences, four were combined manual and automatic, and two were automatic tests. Manual tests conducted were the subcarrier bandedge adjustment, the subcarrier pre-emphasis adjustment, the transmitter center frequency and deviation checks, the SSB ground station frequency response, the SSB translator frequency response, pilot tone, the special service channel verification, channel separation, system insertion loss, voltage standing wave ratio (VSWR) with dummy load, VSWR with antenna, FM/FM transmitter and SSB transmitter output power, FM/FM antenna insertion loss, and SSB/FM antenna insertion loss. Combined manual

4.4.24 (Continued)

and automatic tests included the subcarrier channel verification by means of remote automatic calibration (RACS), inflight/preflight calibration of the T/M calibrator, the SSB translator channel verification, and the model 245 multiplexer channel verification test. The two automatic tests were the subcarrier 5-point linearity test and the SCO program plug verification.

Complete FM/FM and SSB system verification was not accomplished because of schedule requirements for stage shipment to FTC. Additional testing was not conducted, although the need had been established by investigations during testing. The following discussion is a summary of the test problem areas which affected the FM/FM and SSB system verification:

a. During the subcarrier channel verification test, RACS capability was not demonstrated for various vibration, acoustic, strain and flow parameters because a portion of the instrumentation was not installed, electrical cabling was disconnected, system problems were encountered, and procedure errors existed.

b. The model 245 multiplexer channel verification test could not be completed due to malfunction and removal of the multiplexer, P/N 1B32686-509, S/N 02, during this test. FARR 500-489-634 was initiated and dispositioned to remove and replace the multiplexer and retest per the FM/FM and SSB procedure. The multiplexer was removed, but replacement was not scheduled to be accomplished at STC.

c. As a result of the model 245 multiplexer malfunction, the special service channel verification and the SCO program plug verification tests were not completed.

d. The channel separation test was not completed on the SSB system, and the SSB translator channel verification test was not completed for several of the inter-range instrumentation group (IRIG) channels because of the components which were not installed and miswiring of a sequencer connector.

4.4.24 (Continued)

e. The FM/FM and SSB transmitter output power tests were not acceptable because the output power measurements for both transmitters were higher than the maximum allowable limit of drawing 1B52721. Transmitters, P/N 1B52721-511, S/N 020, and P/N 1B52721-517, S/N 006, were rejected on FARR's 500-489-448 and 500-489-456, respectively, and removed for further investigation. Retest with replacement transmitters was not accomplished at STC.

Stage hardware listed in the procedure as not installed during the automatic tests, was limited to vibration instrumentation for measurements E91, E210, E226, E230, E231, E232, E233, E235, E238, and E242.

Seven FARR tags were recorded in the procedure as resulting from the tests, other than those previously described in this narrative.

a. Failure to RAC for vibration parameters E211 and E225 resulted in replacement of the channel calibration decoder, P/N 1A74053-503, S/N 115, per FARR 500-489-626. Retest was not scheduled for STC.

b. The checkout of vibration parameter E251 revealed an out-of-tolerance low level which was rejected on FARR 500-489-693 and submitted for disposition at FTC.

c. FARR 500-489-499 was initiated as a result of an instrumentation malfunction for measurement E92. Minor connector pin damage for the amplifier was corrected by straightening the pin after the test. Retest was not scheduled for STC.

d. FARR's 500-489-375, 500-489-405, and 500-489-413 were initiated due to malfunctions of instrumentation for measurements E210, E238, and E242, respectively. The transducer kits were removed, but retest after kit replacement was not accomplished at STC.

e. FARR 500-489-359 documented damage to the 411W207 cable assembly while disconnecting the cable from T/M antenna 1 in preparation for the FM/FM antenna insertion loss test. The P-2 end connector had been broken loose from the cable assembly. The connector was reterminated per drawing 1B58361, and the test was continued.

4.4.24 (Continued)

Seventy-one revisions were recorded in the procedure as follows:

a. One revision itemized changes and corrections made in the procedure based on Customer review.

b. Thirty-eight revisions were corrections of program and procedure errors.

c. Two revisions were not required and were deleted before being incorporated.

d. One revision authorized substitutions for GSE test cables which were specified in the procedure, but not available at STC.

e. One revision was a convenience change to run transmitter tests individually instead of simultaneously.

f. One revision authorized a special test setup to verify the validity of the original transmitter output power measurements.

g. Seven revisions concerned changes in the test sequencing to facilitate continued testing.

h. Two revisions incorporated a test plan which investigated acoustic and vibration parameters that would not respond to the RACS properly.

i. Two revisions concerned investigations of malfunction indications that resulted in replacement of the channel calibration decoder per FARR 500-489-626 and rejection of vibration parameter E251 on FARR 500-489-693.

j. One revision authorized the performance of the second attempt for the automatic test sequences, after the first attempt was aborted, as previously described in this narrative.

k. Two revisions involved investigation of malfunctioning IRIG channels at the stage SCO mount. Results indicated that the stage hardware was acceptable, and the malfunctions were attributed to improper adjustment of the FM/FM ground station.

l. Three revisions deleted further checkout of functions involving instrumentation which was either not installed at the time of the test or previously rejected and not replaced.

m. Three revisions itemized malfunction indications received as a result of vibration instrumentation electrically disconnected and stage wiring not installed.

4.4.24 (Continued)

n. One revision listed strain measurements that could not be verified because of the model 245 multiplexer malfunction.

o. Two revisions itemized the parameter signals that were not obtained due to part shortages, malfunctioning instrumentation previously rejected but not replaced, incomplete stage wiring harness and sensor cable installation, and procedure error.

p. One revision noted that the channel separation test could not be completed, as previously described in this narrative.

q. One revision indicated that the data obtained for the test of measurements F1 and F2 was not recorded due to error in use of the procedure.

r. One revision noted that response time for the GSE test equipment oscillograph prevented its use for adequate data evaluation.

s. One revision concerned a malfunction of GSE test equipment which had no bearing on stage hardware testing.

4.4.25 Range Safety System (1B55821 J)

The automatic checkout of the range safety system verified the system external/internal power transfer capability and the capability of the system to respond to the propellant dispersion inhibit and trigger commands, the engine cutoff command and the system off command. The items involved in this test included the following:

Part Name	Reference Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	172
Range Safety Receiver 2	411A97A18	50M10697	195
Secure Command Decoder 1	411A99A1	50M10698	0124
Secure Command Decoder 2	411A99A2	50M10698	091
Secure Command Controller 1	411A97A13	1B33084-503	014
Secure Command Controller 2	411A97A19	1B33084-503	013
RS System 1 EBW Firing Unit	411A99A12	40M39515-119	451
RS System 2 EBW Firing Unit	411A99A20	40M39515-119	450
RS System 1 EBW Pulse Sensor	411A99A31	40M02852	*
RS System 2 EBW Pulse Sensor	411A99A32	40M02852	*
Safe and Arm Device	411A99A22	1A02446-503	*
Directional Power Divider	411A97A56	1B38999-1	033
Hybrid Power Divider	411A97A34	1A74778-501	041
*Installed in Pulse Sensor Assembly	411A99A31/32	1B29054-501	00006

Initiated on 12 November 1968, the procedure was accepted as complete on 15 November 1968, after the second attempt. The first attempt was completed on 12 November 1968, but was not acceptable due to the cables on the EBW firing units 1 and 2 being reversed.

Initial conditions for the second attempt were established on 14 November 1968; and the GSE destruct system test set, P/N 1A59952-1, was set up for closed loop operation at 450 MHz with a -50 dbm output level and a 60 kHz deviation. The forward bus 1 and bus 2 battery simulators were turned on, both receivers were verified to be off, and the battery simulator voltages were measured.

4.4.25 (Continued)

The external/internal power transfer test was then started. Both EBW firing units were verified to be off, and external power was turned on for both receivers and both firing units. The firing unit charging voltage indications and the firing unit indications were measured for both range safety systems. The propellant dispersion cutoff command inhibit was then turned on for both receivers. Both firing units were transferred to internal power, and the external power for the units was turned off. Both units were verified to be on, and the charging voltage indications were measured. Both firing units were transferred back to external power and verified to be off, and the firing unit charging voltage indications were again measured. The external power for both receivers was turned off, and the receivers were verified to be off. The receivers were transferred to internal power and verified to be on, then transferred back to external power and verified to be off. Finally, both receivers were transferred back to internal power and again verified to be on.

The EBW firing unit arm and engine cutoff command was turned on and verified to be received by range safety system 1. The system 1 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were off at the umbilical and through the AO and BO telemetry multiplexers, that the nonprogrammed engine cutoff indication was off, and that the instrument unit receiver 1 arm and engine cutoff indication was off. The receiver 1 propellant dispersion cutoff command inhibit was then turned off, and the instrument unit receiver 2 arm and engine cutoff indication was verified to be off. Verification was made that the engine control bus power was then off, that the engine cutoff indications were still off at the umbilical

4.4.25 (Continued)

and through both multiplexers, that the nonprogrammed engine cutoff indication was still off, and that the instrument unit receiver 1 arm and engine cutoff indication was then on. The receiver 1 propellant dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 1 arm and engine cutoff indication was verified to again be off. The EBW firing unit arm and engine cutoff command was turned off. The engine control bus power was turned back on, and the bus voltage was measured. Both firing units were transferred to external power and verified to be off, and the charging voltage indications were measured.

The EBW firing unit arm and engine cutoff command was turned back on and verified to be received by range safety system 2. The system 2 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were off at the umbilical and through the AO and BO telemetry multiplexers, that the nonprogrammed engine cutoff indication was off, and that the instrument unit receiver 2 arm and engine cutoff indication was off. The receiver 2 propellant dispersion cutoff command inhibit was turned off, and the instrument unit receiver 1 arm and engine cutoff indication was verified to be off. Verification was made that the engine control bus power was still on, that the engine cutoff indication was then on at the umbilical and through both multiplexers, that the nonprogrammed engine cutoff indication was then on, and that the instrument unit receiver 2 arm and engine cutoff indication was on. The receiver 2 propellant dispersion cutoff command inhibit

4.4.25 (Continued)

was turned back on, and the instrument unit receiver 2 arm and engine cutoff indication was verified again to be off. The EBW firing unit arm and engine cutoff command was turned off. The engine ready bypass was turned on, and the engine cutoff indication was verified to be off at the umbilical.

The EBW pulse sensor power and pulse sensor self test were turned on, and both range safety pulse sensors were verified to be set. The pulse sensor reset was turned on, and both pulse sensors were verified to be reset. Each of the range safety systems was individually tested by the following steps, starting with system 1. The propellant dispersion command was turned on and verified to be received by the receiver under test. The appropriate firing unit charging voltage indication was measured, and the appropriate pulse sensor was verified to be off. The propellant dispersion command was turned off, the propellant dispersion cutoff command inhibit for the receiver under test was turned off, and the propellant dispersion command was turned back on. For the system under test, the firing unit charging voltage indication was measured; and the pulse sensor was verified to be on. The propellant dispersion cutoff command inhibit was then turned back on, and the propellant dispersion command was turned off. The above steps were then repeated to test system 2. After the test of system 2, the propellant dispersion cutoff command inhibit was turned off for both receivers; and the engine control bus power was verified to be off.

The range safety system off test was conducted next. The range safety system off command was turned on, and power for receiver 1 and the system 1 EBW firing unit was verified to be off. The range safety system off command was turned

4.4.25 (Continued)

off, receiver 2 was transferred to internal power, the range safety system off command was turned back on, and the power for receiver 2 and the system 2 EBW firing unit was verified to be off. The range safety system off command was then turned back off.

The safe and arm device was tested next. The safe-arm safe command was turned on, the safe indication was verified to be on, and the arm indication was verified to be off. The safe-arm arm command was turned on, the safe indication was verified to be off, and the arm indication was verified to be on. The safe-arm safe command was turned back on, again the safe indication was verified to be on, and the arm indication was verified to be off.

Engineering comments noted that there were no part shortages affecting this test. There were a total of two revisions written to the procedure:

a. One revision authorized the second attempt of the procedure. The first attempt was aborted due to reversed cables on EBW firing units 1 and 2.

b. One revision verified that there was no interplay between the range safety system and the stage depletion sensors.

4.4.25.1 Test Data Table, Range Safety System

Function	Measured Value (vdc)	Limits (vdc)
Forward Bus 1 Battery Simulator	28.438	28.0 $\pm$ 2.0
Forward Bus 2 Battery Simulator	28.278	28.0 $\pm$ 2.0
External Internal Power Transfer Test		
External Power On		
System 1 Charging Voltage Indication	4.279	4.2 $\pm$ 0.3
System 1 Firing Unit Indication	4.276	4.2 $\pm$ 0.3
System 2 Firing Unit Indication	4.179	4.2 $\pm$ 0.3
System 2 Charging Voltage Indication	4.194	4.2 $\pm$ 0.3

4.4.25.1 (Continued)

Function	Measured Value (vdc)	Limits (vdc)
Internal Power		
System 1 Charging Voltage Indication	4.294	4.2 ± 0.3
System 2 Charging Voltage Indication	4.189	4.2 ± 0.3
External Power Off		
System 1 Charging Voltage Indication	0.039	0.3 max
System 2 Charging Voltage Indication	0.060	0.3 max
Firing Unit Arm and Engine Cutoff Test		
Engine Control Bus Voltage	27.999	28.0 ± 2.0
Receiver 1 Signal Strength Indication	3.527	3.75 ± 1.25
Receiver 2 Signal Strength Indication	3.579	3.75 ± 1.25
System 1 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.289	4.2 ± 0.3
Engine Control Bus Voltage	27.97	28.0 ± 2.0
External Power Off		
System 1 Charging Voltage Indication	0.050	0.3 max
System 2 Charging Voltage Indication	0.060	0.3 max
System 2 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.199	4.2 ± 0.3
Propellant Dispersion Test		
System 1 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4.305	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On)	1.489	3.0 max
System 2 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor Off)	4.215	4.2 ± 0.3
Charging Voltage Indication (Pulse Sensor On)	1.800	3.0 max

4.4.26 Forward Skirt Thermoconditioning System Postmodification Checkout (1B41883 C)

This procedure tested the forward skirt thermoconditioning system (TCS) in preparation for shipment at the completion of the stage postmodification checkout operations. The procedure utilized the thermoconditioning servicer, P/N 1A78829-1, which had conditioned and supplied the water/methanol heat transfer fluid to the forward skirt TCS, P/N 1B38426-513, during postmodification operations.

Checkout included the water/methanol cleanliness test and specific gravity test, the TCS differential pressure test, the TCS drying and leak check procedure, and preparation for shipment. The purpose of the cleanliness test was to ensure against contamination of the water/methanol solution that could cause TCS system failure by such conditions as restriction of flow or pump abrasion.

The specific gravity test checked for proper water/methanol concentration to obtain valid measurements during the TCS differential pressure test, which in turn was conducted to check for correct TCS system geometry and flow distribution. A drying procedure utilized gaseous nitrogen to purge the TCS system of water/methanol vapor prior to the system leak check. A final GN_2 purge was conducted to dry the TCS after completion of the freon leak check of the TCS.

The final postmodification TCS checkout was initiated on 18 November 1968, and was successfully completed and accepted on 21 November 1968. The water/methanol cleanliness test was conducted first. Water/methanol fluid was circulated through the TCS, then water/methanol samples were obtained and taken to the

4.4.26 (Continued)

laboratory for a particle count. The samples were found acceptable for each micron range. The results for the supply and return samples were identical: no particles in the 175-700 micron range (25 particles allowable), no particles in the 700-2500 micron range (5 particles allowable), and no particles over 2500 microns (none allowable).

Next, the specific gravity and temperature of the water/methanol solution was measured with a hydrometer and thermometer, respectively, determining that the solution was within the acceptable mixture range for the required differential pressure testing band. The differential pressure test was then conducted by measuring the differential pressure between the TCS supply and return lines from the servicer, plus the supply and return temperatures, with a water/methanol flow rate of 7.8 $\pm$0.1 gpm at a supply pressure of 42.0 $\pm$0 psig. The differential pressure was recorded at 18.7 psi with fluid supply temperature and return temperature both at 79°F.

Prior to leak checking the TCS, the system was purged of water/methanol with GN_2 until a system dryness of 25°F dewpoint was obtained, as verified by an Alnor dewpoint meter. Next, an inspection of the TCS panels for open equipment mounting bolt holes and properly torqued bolts was accomplished satisfactorily, indicating readiness for the system leak checks. The thermoconditioning system was then pressurized to 32 $\pm$1 psig with freon gas and leak checked with the gaseous leak detector, P/N 1B37134-1. The areas checked for leakage included all TCS B-nuts, fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold bellows. No leakage was detected, and the TCS was then purged of freon with GN_2 pressurized to 32 $\pm$1 psig.

4.4.26 (Continued)

The final operation consisted of disconnecting and securing the servicer and preparing the TCS for the stage shipment.

There were no FARR's initiated as a result of this checkout, and no discrepancies were noted.

One revision was written to change the callout to close the GN_2 valve V751 to "close thermoconditioner supply valve on the access kit pneumatic panel, level 9." The referenced valve was not numbered.

4.5 Final Inspection

A final inspection was accomplished by MDAC and AFQC personnel on all stage mechanical and electrical areas, to locate and correct any remaining discrepancies. The inspection was initiated on 20 November 1968, and was completed on 27 November 1968, to verify that the stage was in satisfactory condition for shipment to FTC.

A total of 314 defects were noted during this inspection, 248 by MDAC personnel and 66 by AFQC personnel. Of the 248 discrepancies noted by MDAC personnel, 70 were concerned with electrical components and 178 were concerned with mechanical components. Of the 66 discrepancies noted by AFQC personnel, 18 were concerned with electrical components and 48 were concerned with mechanical components.

Most of these discrepancies were corrected without requiring FARR action, but 31 items were transferred to FARR's for disposition:

a. FARR 500-489-570 reported that the insulation on the LH_2 duct, P/N 1A39301, was debonded near the LH_2 prevalve. The insulation was acceptable without rework to the Material Review Board.

b. FARR 500-489-669 noted that several cable support nyafil standoffs had stripped threads. The damaged inserts were removed and replaced.

c. FARR 500-608-293 noted damage to the insulation of cable assembly, P/N 1B58252-1, near LH_2 pressurization line on the forward dome. The damage was repaired under the direction of MM-RE. After rework, the cable assembly was accepted for use.

4.5 (Continued)

d. FARR 500-488-131 noted that the koratherm insulation was cracked approximately 1 inch by 4 inches adjacent to stringer 119 and 8 inches forward of the LH_2 childown pump. The disposition was given to resubmit the condition to the FTC Material Review Board.

e. FARR 500-489-723 noted the following discrepancies:

1. Insufficient clearance between the convolutions of the continuous vent duct, P/N 1B44575-502, between stringers 95 and 103. The attach and securing bolts for the continuous vent duct were released, and the flex elbow was rotated to relieve the preload. Two 6061-T6 shims were added between the mounting clamp and the duct at stringer 103. The mounting holes at stringer 95 were slotted to accept the clamp without preloading the duct.

2. Several areas of corrosion on the O_2H_2 burner. Acceptable to Engineering without rework.

3. Many areas of corrosion on the stainless steel throughout the 403 external area. Acceptable to Engineering without rework.

4. Oxidation on the LOX low pressure duct; the LH_2 low pressure duct; the LOX chilldown return line; and the tube assembly, P/N 1B75818-1, on the stage side of the customer connect panel. Acceptable to Engineering without rework.

4.6 Weight and Balance Procedure (1B55602 E)

This procedure measured the stage weight with an accuracy of ± 0.1 per cent, using a three point electronic weighing system and determined the longitudinal center of gravity of the stage. The measured stage weight was corrected for gravity and air buoyancy forces to determine the weight at Standard Gravity in in a vacuum. The procedure was initiated on 28 November 1968, after the stage was rotated to a horizontal position and placed on the weighing cradles, P/N 1A68719-1. The procedure was accepted on 2 December 1968.

4.6 (Continued)

Before starting the weighing operation, the electronic weighing system, P/N 1A57907-1, was setup and calibrated. Three load cell assemblies, P/N CMU-1204 or 1B38965-1 and -501, were connected to the load cell readout indicator, P/N CMU-1204, checked for linearity and stability by the use of the indicator standardizer, and adjusted for a zero setting. The stage was verified to be level within 0.250 inches over the axial distance between stations 554.702 and 286.147. The dry bulb temperature, barometric pressure, and relative humidity were measured in the weighing area for use in determining the air density. These measurements were repeated every half hour throughout the weighing operation.

Using the hand pumps on the aft jack, P/N 1A93232-1, and the two forward glide-air jacks, P/N 1A83320-1, the stage was raised to just clear the cradles and leveled to the previous limit. Regulator air pressure was applied to the forward glide-air jacks to permit self-adjustment of the stage, and the stage levelness was reverified. After allowing 10 minutes for load cell creep stabilization, load cell readings were taken as shown in Test Data Table 4.6.1. The stage was then lowered back onto the cradles; the load cells were allowed to creep stabilize again; and the load cell zero was rechecked and adjusted, if necessary. The weighing procedure was repeated three times, and the average reading for each load cell was determined and corrected for calibration. From the capacity of each load cell and the load cell reading, the reaction force on each load cell was determined. These reaction forces were then used to

4.6 (Continued)

determine the stage shipping and handling weight, the stage weight at Standard Gravity in a vacuum, and the longitudinal center of gravity. As shown in the Test Data Table, the stage shipping and handling weight was 27,556.0 pounds, the weight at Standard Gravity in a vacuum was 27,609.3 pounds, and the longitudinal center of gravity was at station 330.3.

No parts were short during this procedure, no revisions were written, and no problems were encountered.

4.6.1 Test Data Table, Weight and Balance Procedure

Air Density Data

Time	Barometric Press (in. Hg)	Relative Humidity (%)	Dry Bulb Temp (°F)
00:00	30.001	50.0	60.0
00:30	30.000	50.0	62.0
01:00	29.999	48.0	62.0
01:30	30.000	48.0	60.0
02:00	30.000	48.0	60.0
02:30	30.000	48.0	60.0

Calculated Air Density: 0.0762 pounds per cubic foot

Load Cell Collected Data

Reaction Load	Aft (R1)	Forward (R2)	Forward (R3)
Serial Number	36243	34251	34180
Capacity (pounds)	25,000	10,000	10,000
Run 1 Reading (%)	81.177	39.922	39.950
Run 2 Reading (%)	81.180	39.791	40.007
Run 3 Reading (%)	81.156	39.910	39.937
Average Reading (%)	81.171	38.874	39.965
Calibration Correction	0.989	0.241	0.218
Corrected Reading (%)	82.160	40.115	40.183
Reaction (pounds)	20,540.0	4,011.5	4,018.3

4.6.1 (Continued)

Weight Determination (pounds)

Aft Reaction R1	20,540.0
Forward Reaction R2	4,011.5
Forward Reaction R3	4,018.3
Total Reactions as Recorded	28,569.8
Minus Weighing Equipment "Tare"	-1,013.8
Shipping and Handling Weight	27,556.0
Plug Gravitational Correction	19.3
Plus Buoyancy Correction	34.0
Weight at Standard Gravity in a Vacuum	27,609.9

Longitudinal Center of Gravity

Reaction R1 Moment at Sta. 189.3	3,888,222.0
Reaction R2 Moment at Sta. 684.0	2,743,866.0
Reaction R3 Moment at Sta. 684.0	2,748,517.2
Moment Sum	9,380,605.20
Tare Moment	- 278,870.75
Moment Sum Less Tare	9,101,734.45

As weighed Center of Gravity = Station 330.3
(Moment Sum Less Tare Divided by Total Reactions Less Tare)

4.7 GN_2 Electrical Air Carry Preshipment Purge (1B65454 H)

Just prior to stage shipment, this procedure purged the stage to a dewpoint of -30°F (235 ppm by volume) or less, using gaseous nitrogen and installed the necessary desiccants for stage air carry shipment. The desiccants maintained a clean, dry environment and a safe differential pressure during air transportation.

The procedure was satisfactorily performed between 26 September and 1 December 1968, and was accepted on 3 December 1968. The purge preparations started with the installation of the LOX and LH_2 desiccant support assemblies, P/N's 1B61272-1 and 1B61270-1. The LOX bellows, P/N 1A49971-501, and the LOX and

4.7 (Continued)

LH_2 disconnects, P/N's 1A49970-503 and 1B66932-501, were removed for separate shipment with the stage. Covers and desiccators were installed at the LOX and LH_2 fill and drain vents, the LH_2 propulsive, nonpropulsive, and ground vents, the LOX propulsive and nonpropulsive vents, and the O_2H_2 burner nozzle.

The purge unit, P/N 1B51117-1, was prepared for operation, and the electrical and pneumatic purge connections were made on the stage and between the purge unit and the stage. The engine LOX chilldown line and LH_2 feed duct; the LH_2 pressurization line; the LH_2 propulsive vent, nonpropulsive vent, and ground vent; the LOX propulsive vent and nonpropulsive vent; the O_2H_2 burner LOX and LH_2 ducts; and the LOX and LH_2 propellant tanks were all purged with gaseous nitrogen. The final dewpoints attained were -33.0°F for the LOX system and -30.0°F for the LH_2 system. The LOX tank desiccant breather, P/N 1A79691-1, and the four LH_2 tank desiccant breathers, P/N 1A79691-501, were prepared, filled with desiccant material, and installed.

After the satisfactory completion of the purge operation, the purge unit was disconnected from the stage and secured. The aft skirt dust cover, P/N 1B61077-1, and the forward skirt dust cover, P/N 1B61099-1, were then installed to complete the procedure.

There were no parts shortages affecting this test. FARR 500-608-323 reported that electrical receptacle 404A4J5 had a hole in the rubber insert near pin i. The receptacle was accepted without rework.

4.7 (Continued)

Eleven revisions were made to the procedure for the following:

a. Three revisions authorized the use of substitute parts.

b. Three revisions deleted steps that were performed by other procedures.

c. One revision authorized the installation of the LH_2 desiccant cradle assembly with the 4 LH_2 tank desiccant breather assemblies installed to facilitate installation of the desiccant system.

d. One revision provided for the use of a 0-1000 psi Heise gauge in place of a pressure regulator. The required regulator was not available.

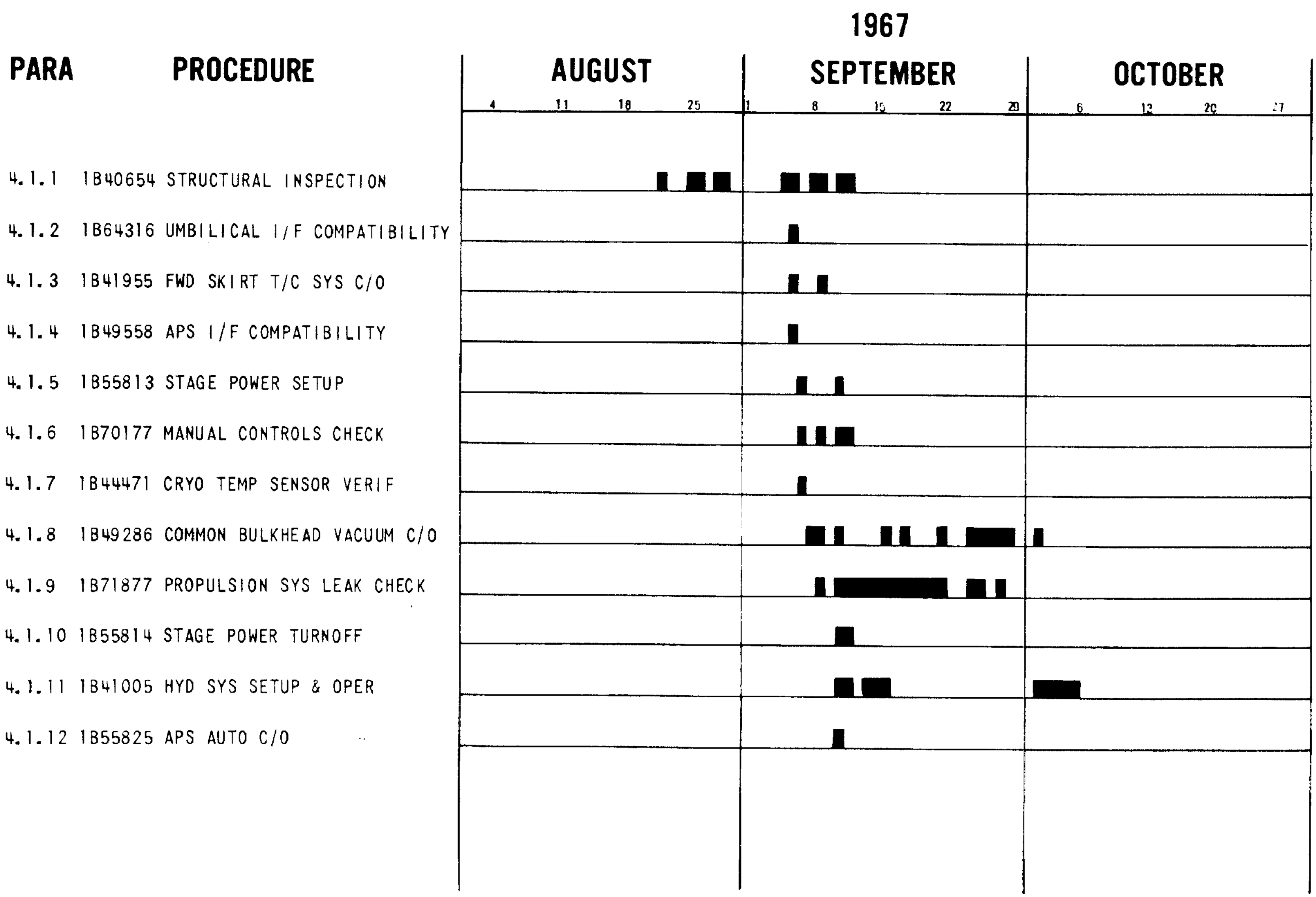
e. One revision deleted the LOX start tank purge, as the purge had been accomplished through the use of the engine LOX purge lines.

f. One revision deleted a step that was not required due to a relief valve not being installed.

g. One revision outlined the steps required to install a heater into the purge system for more efficient use of the GN_2 purge gas. The revision also included instructions for returning the system to its original configuration upon completion of the purge.

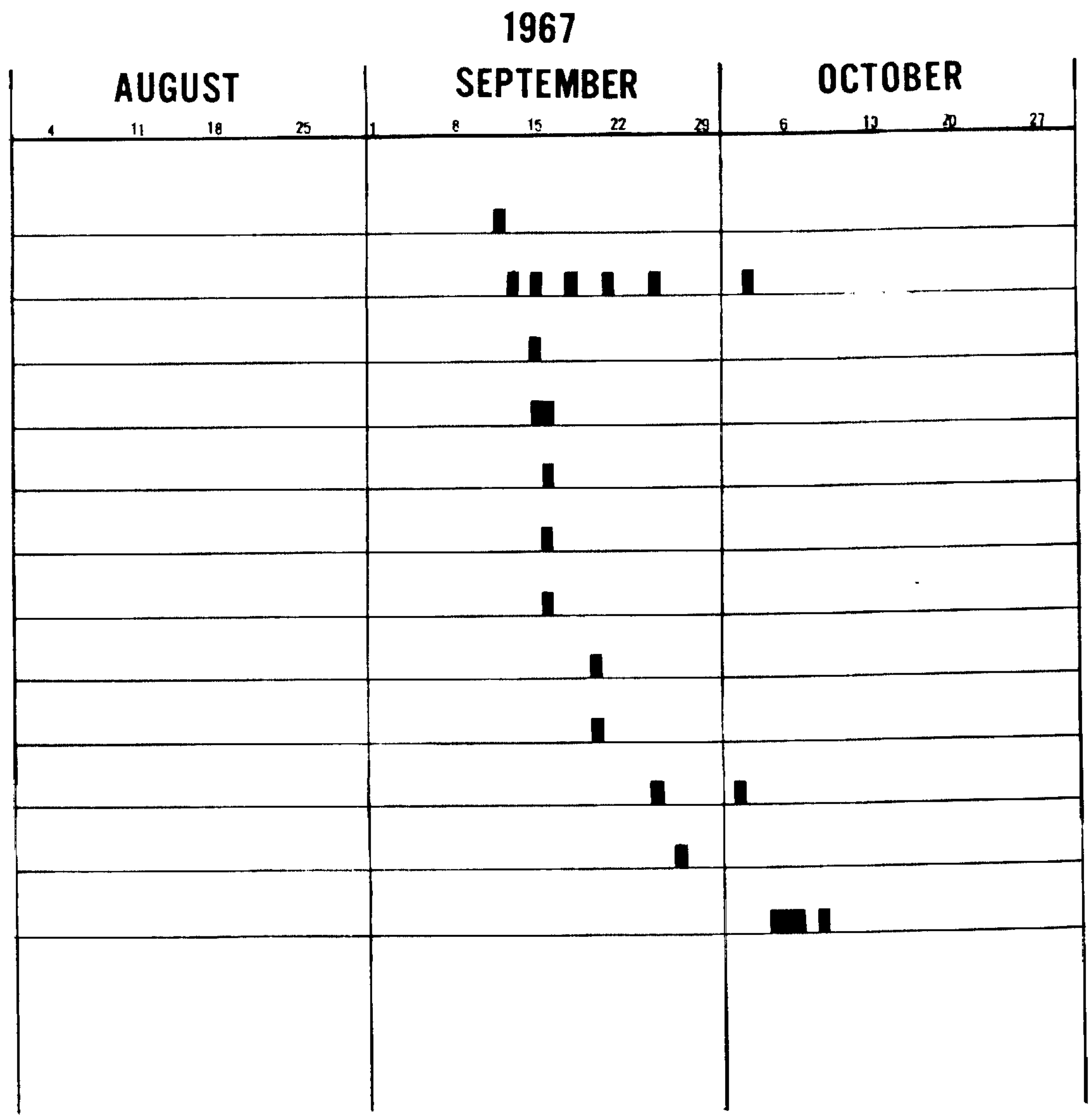
APPENDIX I
TESTING SEQUENCE

505N PREFIRE ACCEPTANCE TESTING



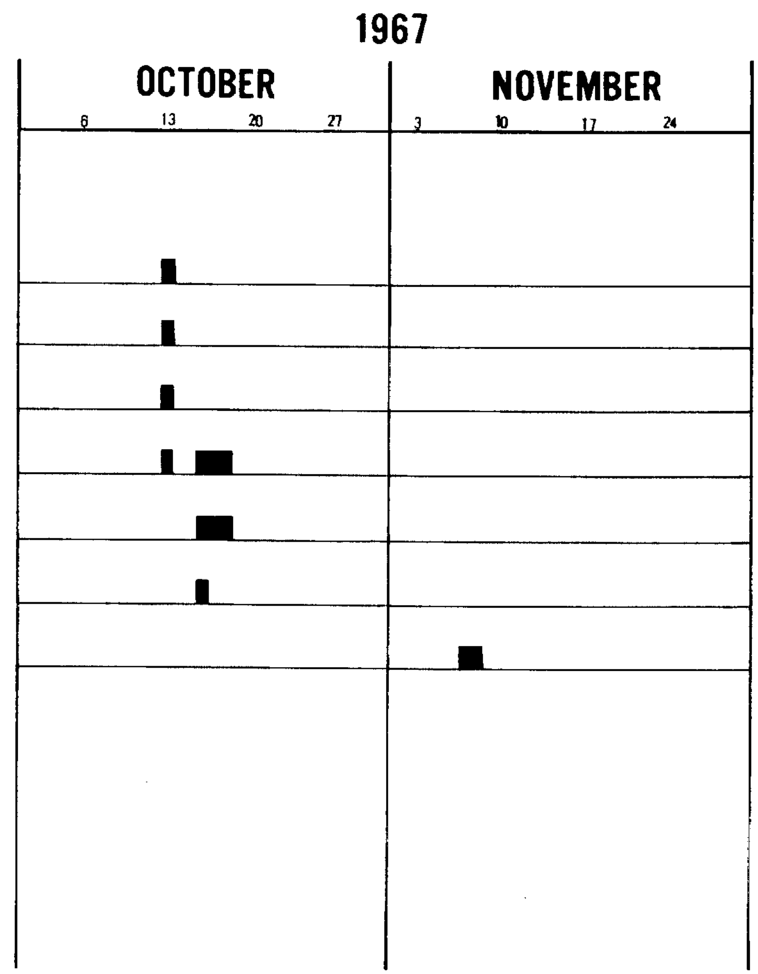
505N PREFIRE ACCEPTANCE TESTING (Cont'd)

PARA	PROCEDURE
4.1.13	1B55815 POWER DISTRIBUTION SYS
4.1.14	1B44472 T/M & RS ANTENNA SYS
4.1.15	1B44473 LEVEL SENS & CONT UNIT CALIB
4.1.16	1B64368 PU SYS CALIBRATION
4.1.17	1B55816 DDAS CALIBRATION
4.1.18	1B55823 PU SYS AUTO C/O
4.1.19	1B55822 EBW SYS AUTO C/O
4.1.20	1B55821 RANGE SAFETY SYS AUTO C/O
4.1.21	1B62753 PROPULSION SYS AUTO C/O
4.1.22	1B55817 DDAS AUTO C/O
4.1.23	1B55831 INTEGRATED SYSTEMS TEST
4.1.24	1B70175 FINAL PROP SYS LEAK CHECK



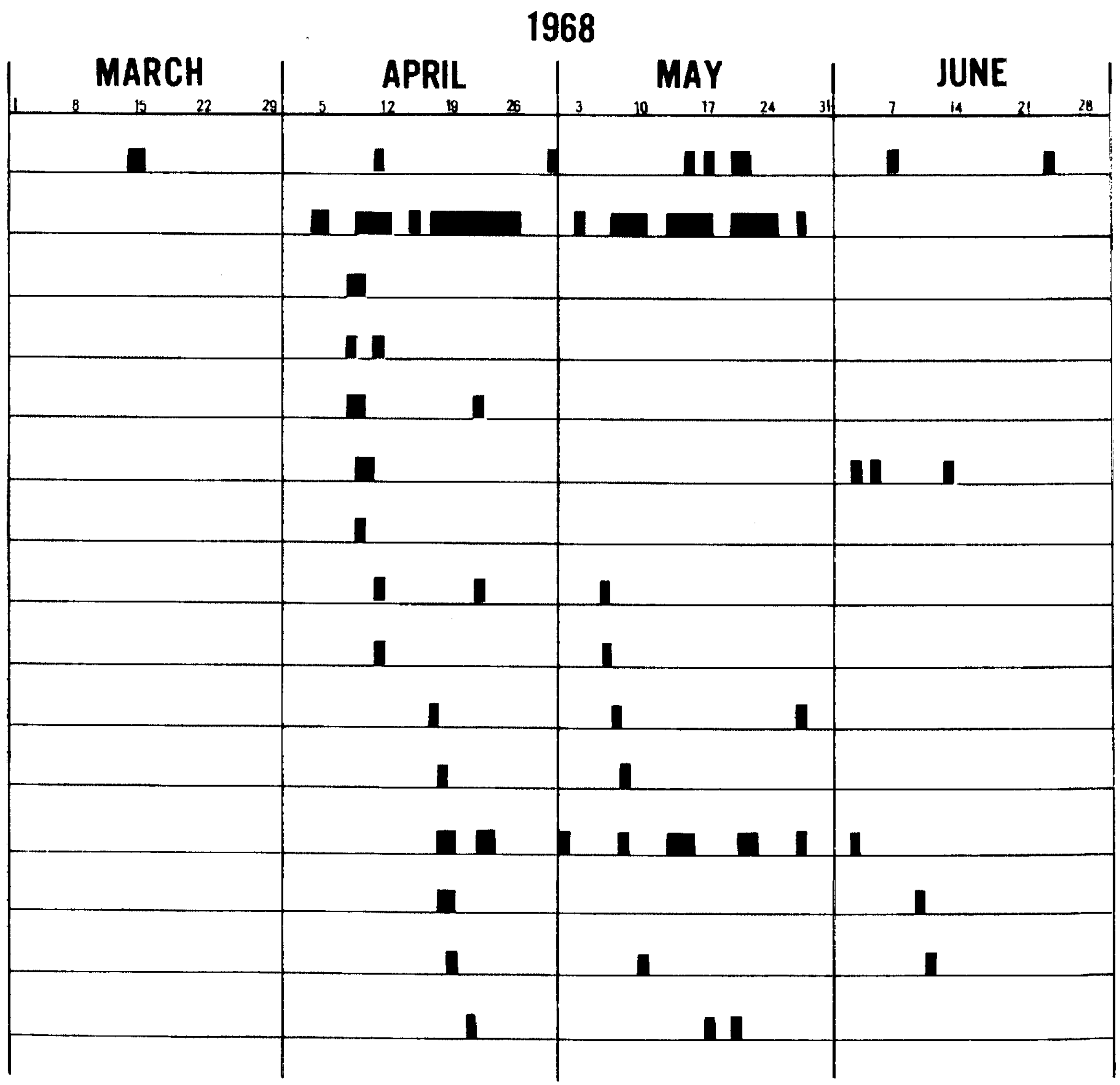
505N POSTFIRE ACCEPTANCE TESTING

PARA	PROCEDURE
4.2.1	1B55813 STAGE POWER SETUP
4.2.2	1B55814 STAGE POWER TURNOFF
4.2.3	1B55831 INTEGRATED SYSTEMS TEST
4.2.4	1B70175 FINAL PROP SYS LK CHECK
4.2.5	1B70756 POSTFIRE STRUCTURAL INSPECTION
4.2.6	1B41006 HYD SYS POSTFIRE OPER & SECURE
4.2.7	1B41883 FWD SKIRT T/C POSTFIRE C/O



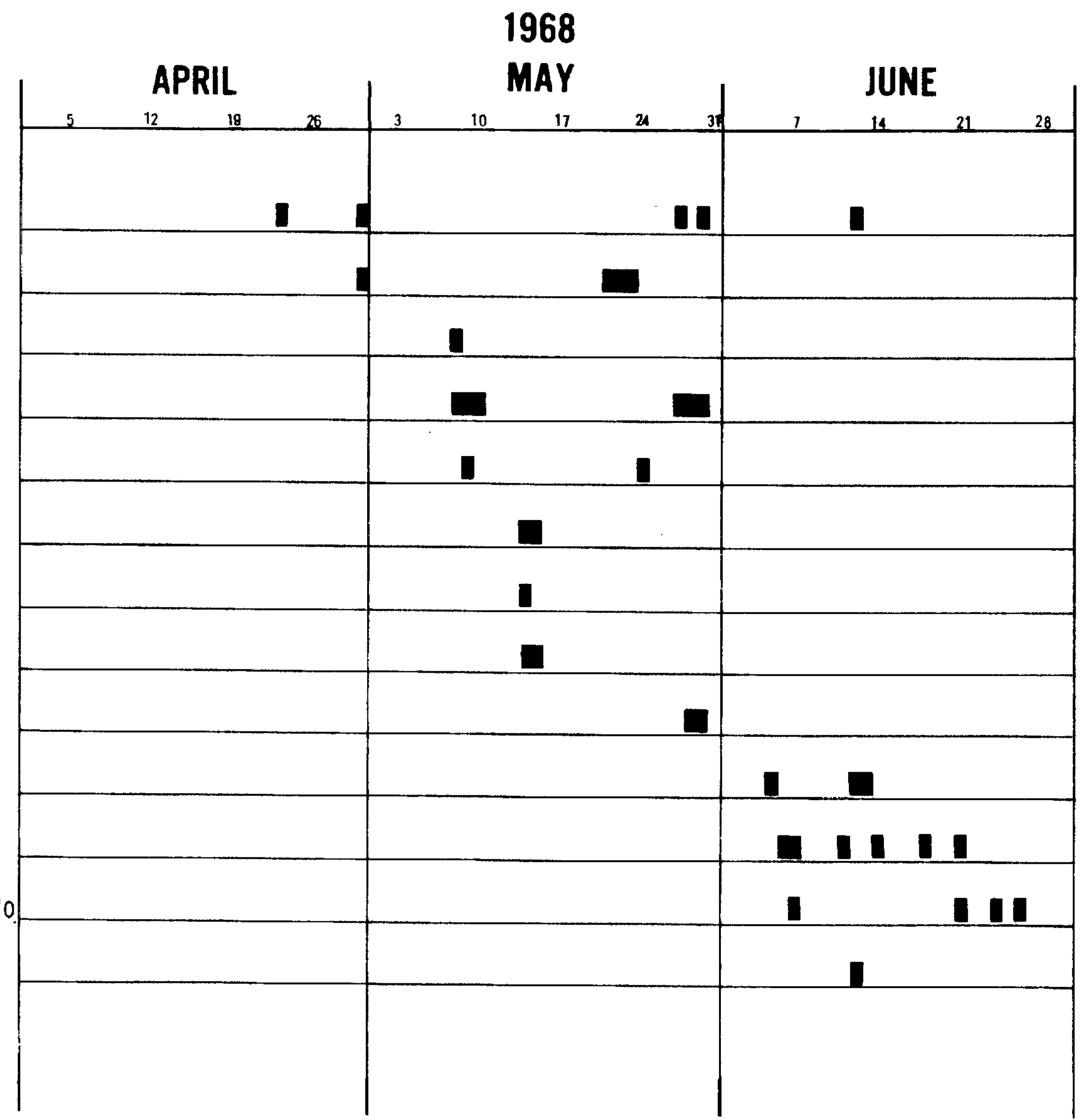
505N POSTSTORAGE ACCEPTANCE TESTING

PARA	PROCEDURE
4.3.1	1B70756 STRUCTURAL INSPECTION
4.3.2	1B71877 PROPULSION SYS LK CK
4.3.3	1B41955 FWD SKIRT T/C SYS C/O
4.3.4	1B70177 MANUAL CONTROLS CHECK
4.3.5	1B44471 CRYO TEMP SENSOR VERIF
4.3.6	1B64316 UMB I/F COMPATIBILITY
4.3.7	1B49558 APS I/F COMPATIBILITY
4.3.8	1B55813 STAGE POWER SETUP
4.3.9	1B55814 STAGE POWER TURNOFF
4.3.10	1B55816 DDAS CALIBRATION
4.3.11	1B55815 POWER DISTRIBUTION SYS
4.3.12	1B41005 HYD SYS SETUP & OPER
4.3.13	1B64368 PU SYS CALIBRATION
4.3.14	1B55823 PU SYS AUTO C/O
4.3.15	1B62753 PROPULSION SYS AUTO C/O



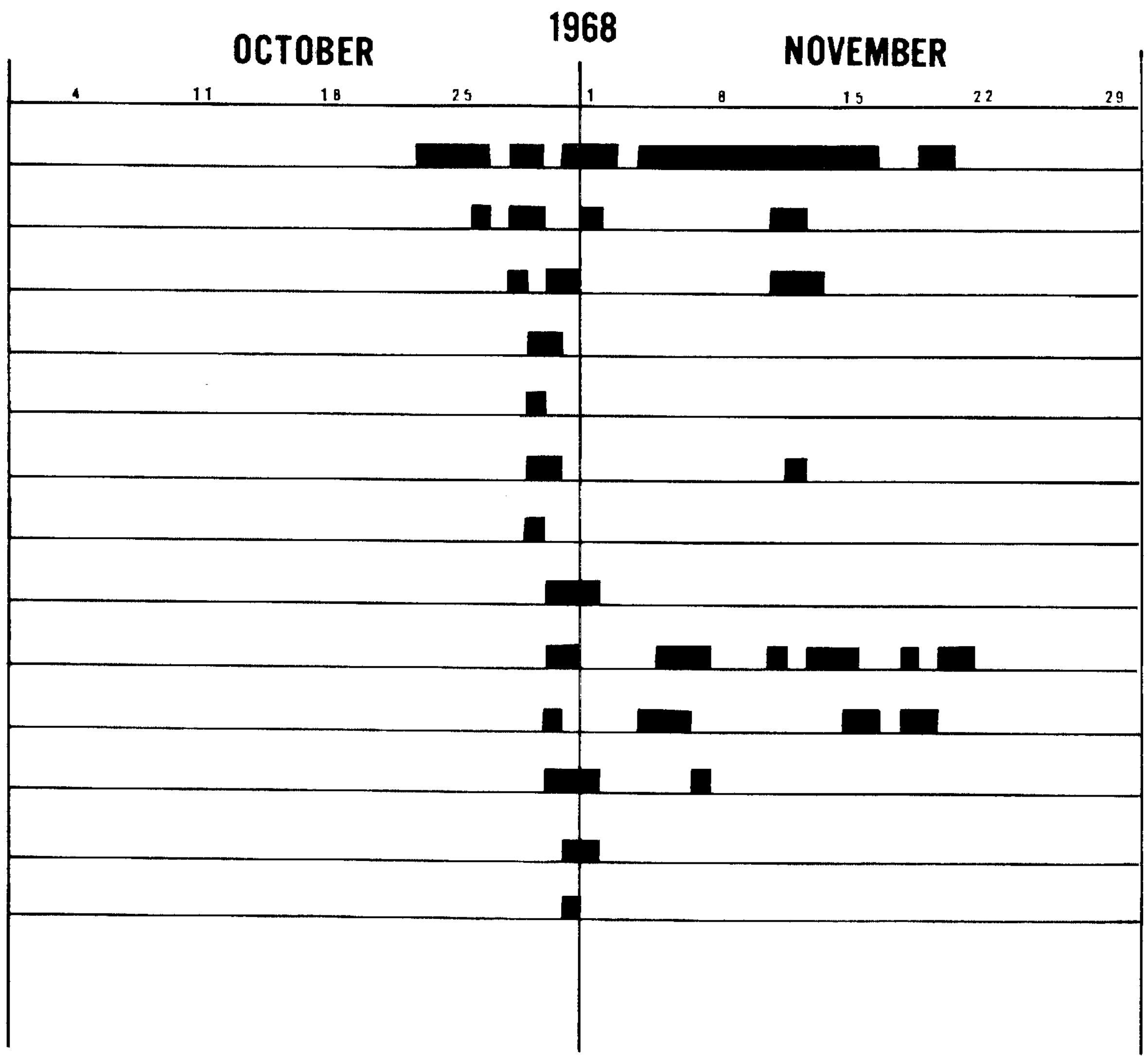
505N POSTSTORAGE ACCEPTANCE TESTING (Cont'd)

PARA	PROCEDURE
4.3.16	1B55817 DDAS AUTO C/O
4.3.17	1B44474 SIGNAL COND SETUP
4.3.18	1B55822 EBW AUTO C/O
4.3.19	1B70430 APS SYSTEM C/O
4.3.20	1B66774 APS AUTO C/O
4.3.21	1B55824 HYD SYS AUTO C/O
4.3.22	1B55819 RANGE SAFETY RECEIVER C/O
4.3.23	1B55821 RANGE SAFETY SYS C/O
4.3.24	1B44473 LEVEL SENS & CONT UNIT CALIB
4.3.25	1B55833 ALL SYSTEMS TEST
4.3.26	1B41006 HYD SYS OPER & SECURE
4.3.27	1B41883 FWD SKIRT T/C SYS POSTFIRE C/O
4.3.28	1B44472 TM & RS ANTENNA SYS C/O



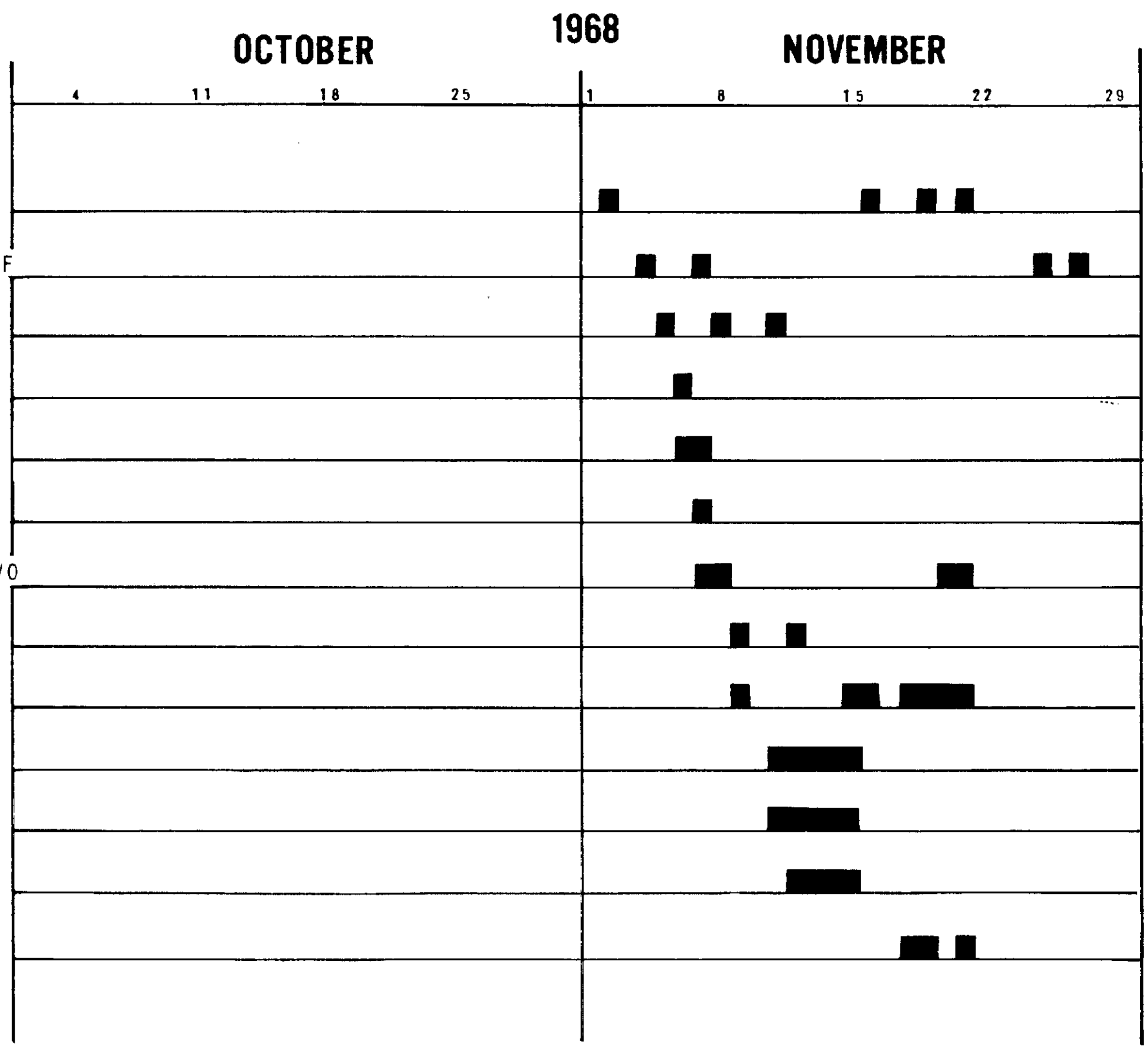
505N POSTMODIFICATION RETEST

PARA	PROCEDURE	
4.4.1	1B71877	PROPULSION SYS LK CK
4.4.2	1B41955	FWD SKIRT T/C SYS C/O
4.4.3	1B70177	MANUAL CONTROLS CHECK
4.4.4	1B64316	UMB I/F COMPATIBILITY
4.4.5	1B49558	APS I/F COMPATIBILITY
4.4.6	1B55813	STAGE POWER SETUP
4.4.7	1B55814	STAGE POWER TURNOFF
4.4.8	1B55815	POWER DISTR SYS C/O
4.4.9	1B41005	HYD SYS SETUP & OPER
4.4.10	1B64681	SIGNAL COND SETUP
4.4.11	1B55825	APS AUTO C/O (SIM)
4.4.12	1B55816	DDAS CALIBRATION
4.4.13	1B55822	EBW AUTO C/O



505N POSTMODIFICATION RETEST (Cont'd)

PARA		PROCEDURE
4.4.14	1B70756	STRUCTURAL INSPECTION
4.4.15	1B64678	CRYO TEMP SENSOR VERIF
4.4.16	1B64680	LEVEL SENSOR & CONT UNIT CALIB
4.4.17	1B64367	PU SYS CAL
4.4.18	1B55823	PU SYS AUTO
4.4.19	1B55824	HYD SYS OPER & SECURE
4.4.20	1B64679	T/M & R/S ANTENNA SYS C/O
4.4.21	1B62753	PROP SYS AUTO
4.4.22	1B55817	DDAS AUTO
4.4.23	1B55819	RANGE SAFETY REC C/O
4.4.24	1B73601	FM/FM & SSB SUBSYSTEM
4.4.25	1B55821	RANGE SAFETY SYS C/O
4.4.26	1B41883	FWD SKIRT T/C SYS C/O



APPENDIX II
TABLES

TABLE I. FAILURE AND REJECTION REPORTS
STAGE RECEIPT TO FORMAL COUNTDOWN INITIATION

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255228 9-6-67	After removal from the stage, the plenum assembly, P/N 1B62278-1, S/N 024, was found to be contaminated.	The plenum was cleaned per DPS 43100; then, reinstalled on the stage.
A255318 9-20-67	During manual setup to checkout the J-2 engine start tank discharge valve, an unexpected pressure buildup in the LOX tank caused the flowmeter in the J-2 engine to spin at approximately 700 rpm for 106 seconds.	Engineering determined that no further condition verification was needed, and the flowmeter was accepted for use. Instructions, already a part of the automatic procedures, for venting the LOX tank to ambient before opening the prevalve or shutoff valve will be given for the manual setups.
A255319 9-20-67	During the performance of procedure 1B70422, it was noted that the flow rate for restrictor, P/N 1B40622-509, S/N 254, was 7.8 scim, and the flow rate should have been 12 $\pm$1 scim.	The restrictor was routed to LOX service for cleaning and retest. The retest resulted in Engineering acceptance of the restrictor, and it was reinstalled on the stage.
A255320 9-27-67	During prefire checkout, it was noted that the first two threads of the filter, P/N 1B59008-501, S/N 1895, showed evidence of galling and excessive lubricant on the threads.	The galled threads were chased, and the filter cleaned per DPS 43000.
A255446 9-6-67	The following discrepancies were noted during prefire checkout:	The defective pins were removed and replaced per DPS 54002-10.
	a. Extended and recessed pins in connectors of wire harness, P/N 1B67152-A45-2B:	

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255446 (Cont.)	1. Connector P3, pin 10. 2. Connector P5, pin 10. 3. Connector P7, pin 12.	
	b. Extended pins in connectors of wire harness, P/N 1B58247-1: 1. Connector P3, pin 8. 2. Connector P13, pins 8, 10, 11, and 13.	
	NOTE: The above discrepancies were verified with a "go-no-go" tool. Pin depth tolerance was 0.065 ±0.015 inches.	
A255448 9-8-67	Inspection during stage power turnon, 1B55813, revealed the following discrepancies:	
	a. Cable assembly, P/N 1B66967-1C, had eight missing wires.	a & b. The missing wires were installed and tested per 1B55813.
	b. Cable assembly, P/N 1B66971-1B, had five missing wires.	
	c. The potted bus connector, P/N 1B57771-559, had five bent pins (A, S, T, U, and V).	c. The bent pins were straightened with a "pin-saver" tool per DPS 54002.
	d. Connector 404A2W1-P21 had five punctures near pins A, S, T, U, and V.	d. Connector 404A2W1-P21 was removed and replaced.
A255450 9-9-67	During prefire radiographic inspection, the presence of foreign objects was noted, through x-ray inspections techniques, at three locations at the junction of the aft skirt and aft dome (V-section).	The foreign bodies were removed with a special laminated glass tool.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255455 8-24-67	During surveillance inspection, it was noted that wires, Q9045A22 and Q9044A22, in wire harness 404W30, had damaged insulation approximately one inch from connector P6.	The damaged wires were removed and replaced per DPS 54002-10.
A255456 8-25-67	During the receiving inspection procedure, a dark discoloration was noted between the J-2 engine thrust chamber valves above the hot gas manifold.	The discoloration was removed with a stainless steel brush. The minor residual discoloration was acceptable to the Material Review Board.
A255457 8-25-67	During removal of pipe assembly, P/N 1B62865-1, debris was noted in the end of the pipe assembly.	The pipe assembly and the pneumatic installation, P/N 1B62778-1, were removed from the stage and routed to LOX service. A subsequent disposition routed a filter, P/N 1B43659, to LOX service. All parts were cleaned per DPS 43000 and reinstalled on the stage.
A255458 8-26-67	The Delron 2086 fastener turned freely inside panel assembly, P/N 1B51295, and should have been bonded securely. The discrepancy prevented installation of the chilldown inverter. The defect was noted during the electrical instrumentation prefire checkout.	The fastener was removed and replaced per 1B39516-1.
A255459 8-28-67	The following discrepancies were noted during receiving inspection:	
	a. Nine dings were found in the thrust chamber.	a. The condition was acceptable to Engineering.
	b. The O_2H_2 burner had two serial numbers, 013 and 086, etched into the body.	b. The serial number of the O_2H_2 burner was verified as S/N 08. The serial number was etched into the burner body.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255459 (Cont.)	c. Tube assembly, P/N 1B62600-11, on the O_2H_2 burner had no evidence of torque or LOX cleanliness being maintained.	c & d. The pipe assemblies were routed to LOX service and cleaned per DPS 43000. The assemblies were re-identified, re-installed on the stage, and tightened to the proper torque value as required.
	d. The identification tape on the pipe assembly between P/N's 1B62606-1 and 1B67825-1 was not legible, and there was evidence of torque or LOX cleanliness being maintained.	
	e. The backshell on connectors 403A20J1, 403A21J1, and 403MT772J1 were loose, and the inspection seals were broken.	e. The connector backshells were retightened and resealed.
	f. Wires routed to connectors 403A21J1 and 403A20J1 had excessive strain at the connectors.	f. The wires were routed per 1B64174.
	g. The electrical connector 404W7P24 was disconnected from receptacle 424A4J1 without removal authority.	g. & h. The electrical connectors were reconnected to the appropriate receptacles.
	h. The electrical connector 404W7P37 was disconnected from plug 403L1J1 without removal authority.	
	i. No evidence of torque on the LOX level sensor feedthrough split clamp was noted.	i. The level sensor was tightened to the proper torque value and sealed.
	j. The mylar insulation on the aft dome was torn or debonded in five places.	j. The torn mylar was patched per DPS 22301, and the debonded areas rebonded per DPS 22301.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255459 (Cont.)	k. The LH_2 shutoff valve mounting bolt and flange bolts were safetywired backwards.	k. The LH_2 shutoff valve mounting and flange bolts were safetywired per DPS 13300.
	l. The upper mounting bracket for the APS module had a loose bolt.	l. The loose bolt was secured and torque striped.
A255460 8-29-67	An inspection for environmental seal and pin damage during electrical instrumentation prefire checkout, revealed eleven environmental seals damaged and seven pins damaged, involving fifteen connectors.	The discrepant connectors were removed and replaced. System reverification was accomplished per propulsion system auto and propellant utilization system checkouts.
A257911 7-12-67	During helium heater modifications, it was noted that transducer cable, P/N 1B40242-71, S/N 559-6, was damaged in two places.	The transducer assembly, P/N 1B40242-559, S/N 559-6, was removed and replaced with S/N 559-5. Originally reported in Table II of Volume I, SSC, Douglas Report DAC-56574. Unit was tested per propulsion system leak check 1B71877 and DDAS subsystem auto 1B55817.
A261601 9-11-67	During a special O_2H_2 burner spark monitor signal verification test for umbilical talkback, four wires and two jumpers were found to be missing from cable assembly, P/N 1B66968-1, in reference location 411A9W1.	The missing wires and jumpers were installed per 1B66968-1.
A261602 9-13-67	During prefire checkout, it was noted that cable assembly, P/N 1B66973-1, had seven missing wires.	The missing wires were installed per 1B66973.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261603 9-13-67	During an engineering run of DDAS checkout, measurement L015 did not indicate ON. Investigation revealed that the remote digital submultiplexer (RDSM), P/N 1B52894-1, S/N 08, was defective.	The RDSM was replaced with S/N 20.
A261604 9-13-67	A record search disclosed that sensor, P/N 1A68710-1, S/N D119, was installed in reference location 408MT734. Per 1B58247-1, the sensor should be P/N 1A68710-507.	Engineering investigation revealed that the difference in configuration was minor, and the sensor was accepted for use.
A261605 9-13-67	During checkout of the telemetry system, it was noted that the power output of the PCM RF transmitter was 26.5 watts. The maximum power output should have been 20 $\pm$5.0 watts.	The transmitter was removed and replaced with S/N 34.
A261606 9-13-67	During leak check of the LOX propellant shutdown valve, P/N 1B66639-503, S/N 021, a leak of 65 scim was noted at the micro switch housing when the valve was in the closed position. The leak check procedure did not specify maximum allowable leakage.	The valve was removed and replaced with S/N 023.
A261610 9-14-67	During prefire checkout and inspection of the helium heater ignition systems, S/N's 027 and 036, it was noted that the ignition electrodes of both units were bent approximately 15 degrees.	The electrodes were removed from the systems and replaced.
A261611 9-19-67	During the electrical cabling and distribution prefire checkout, it was noted that wire No. M28DR-20 was not properly terminated.	The wire was reterminated per 1B66938.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261612 9-10-67	During prefire checkout, the rubber inserts in the electrical connectors of valve assemblies, P/N 1B59010-503, S/N's 102 and 114 were found to be damaged. Further investigation revealed that the ceramic insulators in the electrical connectors of both valves were cracked.	The two discrepant valves were removed from the stage and replaced.
A261613 9-18-67	During an engineering run of the DDAS automatic procedure, NASA measurement C391, transducer, P/N 1B65957-1, S/N 1194, indicated an ambient full scale output of 5.123 vdc. The output at the time should have been -0.123 vdc. Investigation revealed that the lead wires in the transducer were shorted.	The temperature transducer was removed and replaced.
A261614 thru A261618 & A261620 9-19-67	Five Deutsch connectors and one electrical receptacle were documented on FARRS A261614 through A261618 and A261620 for environmental seal damage. The affected parts were: electrical receptacle, P/N DTK-00-18-8098, and Deutsch connectors, P/N's DTK-06-18-809P, DTK-06-14-19S-3005, DTK-06-8-98S-3005, DTK-06-12-10S-3005, and DTK-06-12-10S-3001. The discrepancies were noted during an inspection per WRO S-IVB-3714.	All discrepant parts were removed and replaced.
A261619 9-19-67	During an engineering run of the digital data acquisition system procedure, the VSWR reading for open loop test on the power divider, P/N 1A69215-501, S/N 00044, was too high. The reading was 2.24:1, and maximum VSWR was specified as 1.7:1.	Trouble shooting indicated that the high VSWR reading was due to test stand environmental conditions and not hardware failure. As the condition was not detrimental, the system was accepted for use.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261623 9-21-67	During the performance of the propulsion system automatic checkout, it was noted that the output of the spark monitor signal from the helium heater ignition system, P/N 1B59986-503, S/N 026, was 0.54 vdc. The output should have been greater than 2.5 vdc.	The ignition system was removed and replaced.
A261624 9-22-67	A search of completed inspection records indicated that the cold helium sphere, P/N 1A48858-1, S/N 1127, that was installed in position 3, bank 1 of the LH_2 tank, had been rejected for damage on FARR A170218, which stated to, "replace only". Rework of the damaged area, a gouge of 0.010 inch deep, was accomplished without authority on RPO 6A4402. Test data of the sphere indicated that it was acceptable and was installed on the stage prior to the record search.	The sphere was acceptable for use by the Material Review Board.
A261625 9-22-67	A search of completed inspection records revealed that the cold helium sphere, P/N 1A48858-1, S/N 1012, had been previously installed and used on the facilities checkout stage, S/N 1004, and was dispositioned, "not for production use". The sphere was installed in bank 2, position 9 of stage 505N.	An historical package was compiled which indicated that the sphere had not been subjected to more than product acceptance test environments. Based upon these facts, the sphere was accepted for use by the Material Review Board.
A261626 9-22-67	During prefire checkout of the O_2H_2 burner system, it was noted that the propellant control valves, P/N 1B59010-503, S/N's 102 and 114, had damaged electrical receptacles.	The discrepant control valves were removed and replaced.
A261627 9-21-67	During prefire checkout of the O_2H_2 burner system, it was noted that the LOX shutdown valve, P/N 1B66639-503, S/N 023, failed to transmit a closed talkback indication.	The valve was removed and replaced.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261628 9-25-67	During prefire checkout, it was noted that the helium regulator, P/N 1A66985-511, S/N 88, would not maintain a set pressure.	The regulator was removed from the stage and replaced.
A261629 9-25-67	During prefire checkout, it was noted that the LH_2 propulsion duct, P/N 1B62676-503, S/N 5, would not pump down below 1000 microns.	The duct assembly was removed and replaced.
A261630 9-25-67	During DDAS procedure, transducer, P/N 1B40242-567, S/N 567-2, indicated a high calibration voltage of 3.349 vdc. The reading should have been 4.000 $\pm$0.100 vdc.	The transducer kit was removed and replaced.
A261632 9-27-67	During a special power supply filter test, the upper limit of 30.5 vdc for safety item monitor channel 17 was exceeded by 0.5 vdc for 30 milliseconds by applying 31 vdc to the input of the PU electronics assembly, P/N 1A59358-525, S/N 022.	The PU electronics assembly was accepted for use.
A261633 9-27-67	During a special power supply filter test, the voltage input level of the R/NAA electronic control package and SIM channel 41 was exceeded by 0.5 vdc for 30 milliseconds.	The J-2 engine and the electronics control package were accepted for use.
A261634 9-28-67	During DDAS, the VSWR reading for the open loop test indicated a high out-of-tolerance VSWR of 4.7:1. Maximum VSWR was stated as 3.0:1. This condition was previously rejected and accepted on FARR A261619, dated 9-19-67.	The defective cable assembly was removed and replaced, and retest of the antenna system was acceptable.

TABLE I (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261634 (Cont.)	NOTE: During troubleshooting of this condition, connector P2 of cable assembly, P/N 1B58361-1, was found to be loose.	
A261635 9-29-67	During prefire leak check, a slight bubble leak was noted at the stem of the LH_2 vent purge valve, P/N 1B53817-505, S/N 066.	The vent purge valve was rechecked during postfire leak checks. No increase in the amount of leakage was noted, and the valve was accepted for use.
A261639 10-2-67	During the first performance of IST, a variation between the hydraulic system pitch response times and hydraulic actuator movements was noted.	A retest per segment seven of IST and a troubleshooting routine isolated the cause to be in the counter-timer relays in the signal conditioner, model 13. The stage was then accepted for use by Engineering.
A261641 10-6-67	During prefire leak checks, it was noted that the LOX relief valve, P/N 1A49590-515, S/N 531, leaked through the valve seat at the rate of 400 scim. Maximum allowable leakage was 150 scim.	The relief valve was removed and replaced.
A261643 10-9-67	During prefire inspection surveillance, it was noted that the LH_2 chilldown duct insulation, P/N 1B38694-501, was broken in three places.	The duct insulation was removed and replaced.
A262068 9-13-67	The pipe assembly, P/N 1B58853-1, was removed from the stage and routed to the machine shop to be used as a mockup, where it was erroneously cut in two pieces.	A new pipe assembly was fabricated and installed on the stage.

TABLE II. FAILURE AND REJECTION REPORTS
FORMAL COUNTDOWN INITIATION AND POSTFIRE CHECKOUT

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255321 10-16-67	During performance of the propulsion systems leak check, a bubble leak was found at the junction of the start tank valve and the start tank.	The start tank system was accepted for use by Material Review Board action.
A255322 11-1-67	The following discrepancies were noted during installation of the impingement curtains: a. Seven blind nuts (BB-330-1032-1 sleeves and BB-341-1032 expanders) were installed in the impingement curtain support segment, P/N 1B65110-517, between stringers 22 1/4 and 22 3/4 and four places in the -519 segment between stringers 23 and 23 1/2. The nut installation should have been P/N NAS679A3. b. Two outside attach holes in the support angle, P/N 1B65779-505, and the corresponding location in segment 1B65110-523, had been drilled to 0.3125 inch diameter. The holes should have been 0.140 to 0.145 inches. c. The AN737TW82 clamp was too small to be installed on the LOX recirculation return line. d. There were 346 blind nuts installed where nut plates, P/N NAS680A3, should have been installed as shown per the 1B65109-503 configuration.	All items were acceptable to the Material Review Board.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261644 10-10-67	During the flight critical items section of the countdown test run TR1048, it was noted that an internal leakage of 7 psig in one hour existed in the accumulator reservoir assembly, P/N 1B29319-519, S/N 0023.	The accumulator was removed and replaced.
A261645 10-13-67	During static firing countdown TR1048, the LH_2 fill and drain valve, P/N 1A48240-505, S/N 0045, lost closed talkback. The open continued to function properly. This discrepancy occured while the LH_2 tank was loaded with liquid hydrogen. This malfunction did not exist under ambient conditions.	The LH_2 fill and drain valve was removed from the stage, and a new talkback switch was installed in the valve. A production acceptance test was performed satisfactorily, and the valve was reinstalled on the stage.
A261646 10-12-67	During the static firing countdown for test run 1048, the LH_2 chilldown shutoff valve, P/N 1A49965-523, S/N 0506, lost open talkback on both hardwire and telemetry. This discrepancy occured after the LH_2 tank was loaded with liquid hydrogen. The valve was cycled several times with the talkback malfunctioning each time. The open talkback started functioning when the LH_2 tank was pressurized to 31 psia, when de-tanking was accomplished, and when the valve was returned to ambient temperature.	The talkback switch on the valve was adjusted in place by the vendor, and the rework was accepted by Engineering.
A261647 10-16-67	During the countdown for test run 1048, it was noted that the cold helium bottle pressure decreased from 3000 psig to 2400 psig after initial pressurization. Postfire troubleshooting revealed that the LOX prepressurization check valve, P/N 1B40824-507, S/N 116, was defective and was backflowing.	The check valve was removed from the stage and replaced.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261648 10-16-67	A review of the static firing data indicated that pressure transducer, P/N 1B43324-601, S/N 48-4, had a 5 per cent noise factor when the pressure applied to measurement D180 was above 60 per cent of the transducer's range.	The transducer was removed and replaced.
A261649 10-16-67	During the countdown for test run TR1048, the LOX prevalve, P/N 1A49968-509, S/N 144, failed to give talkback in the open position. This discrepancy occurred one time only. The talkback operated intermittently during the coldflow test.	The prevalve was reworked per E.O.'s 1A49968-A45-6, 1B58003-A45-7, and 1A49968-010C. The valve was acceptable for the coldflow test. The prevalve was removed and replaced subsequent to coldflow.
A261651 10-17-67	The following discrepancies were noted during postfire checkout: a. The korotherm coating had 5 cracks approximately 5 inches long between forward skirt stringers 13 and 14, just above the forward skirt LH_2 tank attach ring. b. The korotherm coating had 2 cracks approximately 2 inches long between forward skirt stringers 17 and 18, just above the forward skirt LH_2 tank attach ring.	The damaged korotherm insulation was repaired per the instructions of SEO 1B65223-003.
A261652 10-17-67	The post static firing data review for test run 1048 revealed that NASA measurement No. D003, oxidizer pump inlet pressure transducer, P/N 1B43324-503, S/N 12-7C, had several data dropouts during repressurization, while operating at 60 to 66 per cent of full range.	The transducer was removed and replaced.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261653 10-18-67	The LH_2 low pressure duct vacuum probe, P/N 8651860G6, was found to be shorted internally.	The vacuum probe was removed and replaced.
A261654 10-16-67	The following discrepancies were recapped from postfire IIS 338183:	
	a. The mylar covering on the forward dome had a tear approximately 3/8 inch by 1 inch, located 4 inches down and 2 inches to the right of the LH_2 prepressurization boss.	a & b. The torn mylar was repaired per DPS 22301.
	b. The mylar covering had a tear approximately 3/4 inch square adjacent to the LH_2 tank vent line boss on the forward dome.	
	c. There were several small cracks in the mylar covering over the LH_2 fill and drain duct, allowing moisture to accumulate on the insulation.	c. The mylar covering was removed and replaced per 1A77906.
A261655 10-18-67	During the postfire data review, it was noted that the bridge module, P/N 1A82274-563, S/N 02610, could not be adjusted for proper calibration values. The low value remained at -1.0 mvdc, and the high value at 22.9 mvdc. These values should have been 0 $\pm$0.05 mvdc and 24 $\pm$0.3 mvdc, respectively.	A retest per 1A98238 verified the noted discrepancy, and the module was removed and replaced.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261657 10-25-67	The following discrepancies were noted during the postfire data review: a. Measurement M0012, static inverter/converter frequency, contained 3 per cent noise during auxiliary hydraulic pump and chilldown inverter operation. b. Measurement M0038, LH_2 chilldown inverter, had 3 per cent noise during chilldown inverter operation. c. M0029, LOX chilldown inverter, had 3 per cent noise during chilldown operation.	The conditions were acceptable to the Material Review Board.
A261659 10-25-67	The multiplexer, P/N 1B62513-547, S/N 013, channels 11-01 and 11-04 had an output of 4.958 vdc during IST, and the channel 29-09 multiplexer, P/N 1B62513-543, S/N 014, failed the inflight calibration during DDAS, with an output of 4.964 vdc. The tolerance for both units was 5.0 $\pm$.03 vdc.	As the causes of the out-of-tolerance reading was due to causes external to the stage, the multiplexers were acceptable for use.
A261660 10-27-67	The following defects were recapped from IIS 338724: a. Support, P/N 1B37888-529, was located 3 1/2 inches forward of the aft weld. Per blueprint, the support should be 2 $\pm$1/8 inches forward of the aft weld. b. Clamp assembly, P/N 1B37862-1, was located 6 inches forward of the aft weld. It should have been located 4 1/2 $\pm$1/8 inch forward.	a & b. The support and clamp assemblies were located per blueprint.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261660 (Cont.)	c. Support, P/N 1B37888-529, zone 8, 1B54540, had not been installed.	c. The support assembly, P/N 1B37888-529, was installed per 1B54540.
A261661 10-30-67	Vidagage inspection of the stage per WRO-S-IVB-3818-R2 revealed the following discrepancies and/or conditions: a. Stringers 5, 8, 23, 55, 56, 120, and 121 were not milled in the aft skirt. b. Stringers 24, 26, 28, 31, 32, 33, 125, and 129 were not hat sections in the aft skirt. c. Stringer 25 did not exist on the exterior of the aft skirt. d. Stringers 29 and 30 were not milled and were small dimension hat sections in the aft skirt. e. Stringers 39 through 42 in the 405 main tunnel area were partially concealed under cabling support plates. f. Stringers 6, 9, 54, and 57 were inspected on one side only in the aft skirt. g. The following stringers were visually inspected only and should have been inspected using a vidagage: 1. Aft skirt - Quad No. 1, stringers 6 - 9, and 23 - 33; Quad No. 2, stringers 39 - 42, 54 - 57,	All noted discrepancies and/or conditions were acceptable to the Material Review Board.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261661 (Cont.)	70, and 71; Quad No. 3, stringers 72 and 73; Quad No. 4, stringers 120, 121, 125 to 129, and 143. 2. Forward skirt - Quad No. 1, stringers 13 - 16 and 19 - 28; Quad No. 2, stringers 35 - 40; Quad No. 3, stringers 69, 70, 78, and 79. 3. Stringers 17 and 19 at the forward skirt hat section were 0.083 inches and should have been 0.097 $\pm$0.010 inches per 1A72748.	
A261662 10-31-67	During inspection of rework per 1A39364-025, a crack approximately 1/2 inch long was found in the lip of fitting, P/N 1B53149-1. Reference 1A39264, zone 86, view AV-AV.	The cracked section was reworked to approximately a 1 inch radius, and all sharp edges were de-burred. The reworked surfaces were protected per finish specification F289.
A261663 11-1-67	During inspection surveillance, pins V and CC of bus module, P/N 1B57771-559, were found to be bent.	The module was removed and replaced.
A261664 11-6-67	During removal of the four set screws, P/N NAS-108104A8, from the LH_2 nonpropulsive vent connection, the loctite inserts, P/N's SPLD-258, were removed with the set screws. These inserts should have been bonded in place.	New Rosan inserts, P/N SPLD-258, and adapters, P/N 1B57264, were installed. Thread sealant DPM 2584 was used to insure proper bond.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261666 11-10-67	The LOX vent system was suspected of being contaminated per laboratory report number 47570.	The LOX tank relief valve, P/N 1A49590-515; the LOX ducts, P/N 1A68611-501 and 1A59434-501; and the LOX vent and relief valve, P/N 1A48312-505, were removed from the stage and visually inspected for contamination. No contamination was found, and all removed parts were re-installed on the stage. After leak checks of the components, the stage was accepted.
A261667 11-14-67	During inspection surveillance, it was noted that wire No. Q9058A22 had insulation damage and bare wire exposed.	The coax contact of the damaged wire was removed from the feedthrough. A sleeve of shrink tubing was placed over the damaged area. After shrinking, the area was wrapped with teflon tape (DPM 2766), and the tape was fused per DPS 54010. The connector was reassembled, and the rework was accepted.
500-024-135 10-19-67	During pre cleaning operations in LOX service, it was noted that the injectors, P/N 1B7723-1, S/N's 05 and 06, had scratches and nicks on the sealing surfaces. The depth of the scratches ranged from 0.0005 to 0.002 inches.	The sealing surfaces were smoothed out with 400 grit aluminum oxide paper. After polishing, each injector was capped and leak checked with 15 psig of helium. No leaks were detected, and the injectors were accepted for use.

TABLE III. FAILURE AND REJECTION REPORTS
POSTSTORAGE ACCEPTANCE TESTING

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A255339 4-24-68	The vent port check valve, P/N 1B67481-1, S/N 70621300, exhibited a cracking pressure of 5 psig. Maximum cracking pressure, per 1B70422, was less than 4 psig.	The valve was routed to LOX service and retested. The test indicated a cracking pressure of 3.8 psig. The valve was accepted for use on the stage.
A255231 4-22-68	The vent port check valve, P/N 1B67481-1, S/N 708305, exhibited a reverse leakage of 0.5 scim. Maximum leakage, per 1B70422, was specified as 0 scim.	The valve was routed to LOX service and retested with a tolerance of 10 scim maximum leakage. The valve was accepted for use and was reinstalled on the stage.
A255232 4-24-68	The vent port check valve, P/N 1B67481-1, S/N 70621181, exhibited a reverse leakage of 3.3 scim. Maximum allowable reverse leakage, per 1B70422, was expressed as 0 scim.	The valve was routed to LOX service and retested with a tolerance of 10 scim maximum leakage. The valve was accepted for use on the stage.
A255233 4-24-68	The vent port check valve, P/N 1B67481-1, S/N 70621299, exhibited reverse leakage in excess of the 0 scim maximum as specified in 1B70422.	The valve was routed to LOX service and retested with a tolerance of 10 scim maximum leakage. The valve was accepted for use on the stage.
A255234 4-24-68	The vent port check valve, P/N 1B67481-1, S/N 70621238, exhibited reverse leakage of 8 scim. Maximum leakage, per 1B70422, was 0 scim.	The valve was routed to LOX service and retested with a tolerance of 10 scim maximum leakage. The valve was accepted for use and reinstalled on the stage.
A261715 thru A261720 4-3-68	During the reverse leakage check section of the propulsion system leak checks, the following vent port check valves, P/N 1B67481-1, indicated reverse leakage:	A retest of the check valves revealed that the leakage was due to a bad seal in a test plate. No leakage was detected in the check valves.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261715 thru A261720 (Cont.)	S/N 70621147 S/N 7062160 S/N 70621196 S/N 7062174 S/N 70621102 S/N 70621214 Maximum leakage allowable, per 1B70422, was specified as 0 scim.	
A261811 1-11-68	An inspection line check revealed that the LH_2 vacuum jacketed duct assembly, P/N 1B59005-501, S/N 7, had rust colored residue in the weld areas.	The duct assembly was removed from the stage and cleaned per DPS 43000, then reinstalled on the stage.
A261812 1-11-68	An inspection line check revealed that the LOX vacuum jacketed duct assembly, P/N 1B59009-501, S/N 15, had rust colored residue in the weld areas.	The duct assembly was removed from the stage and cleaned per DPS 43000, then reinstalled on the stage.
A261813 1-11-68	During an inspection line check, it was noted that the LH_2 vacuum jacketed duct assembly, P/N 1B65206-503, S/N 12, had rust colored residue on the weld areas.	The duct assembly was removed from the stage and cleaned per DPS 43000, then reinstalled on the stage.
A262226 3-25-68	Duct assembly, P/N 1A68611-501-001, was found to have the following discrepancies: a. Two convolutions on the outlet end of the duct were dented. b. The metal inlet end of the duct, between the flange and the bellows, was eroded.	The duct assembly was accepted by Engineering for use.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A270601 5-7-68	During packaging for shipment to LOX service, the following discrepancies were found on the LH_2 fill and drain valve, P/N 1A48240-505-007, S/N 0135: a. The sealing surface on the outlet side was scored in the area where the conoseal makes contact. b. The protective alodine coating on the sealing surface was scratched.	The valve was accepted for use by Engineering.
A270619 9-17-68	During inspection of the LOX probe, P/N 1A48430-509-011, S/N D-9, pin No. 11 of the connector was found to have been bent.	The bent pin was straightened with a modified type 555 pin straightening tool. After rework, the connector was leak checked, and the probe was accepted.
A270630 7-25-68	During a special pull test, vibration isolator, P/N 1B32267-1, located on the right aft side of panel 19, was found to be debonded.	The isolator was removed and replaced.
A270631 7-25-68	During a special pull test, vibration isolator, P/N 1B32258-1, located under panel No. 4 between stringers 60 and 68, was found to be debonded.	The isolator was removed and replaced.
A270632 7-26-68	During a special pull test, vibration isolator, P/N 1B32258-1, S/N 027, located on panel 18 between stringers 10 and 14, was found to be debonded.	The isolator was removed and replaced.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A270651 4-17-68	It was noted that the cutout in the aft skirt assembly, P/N 1A39295-7-5, for the nonpropulsive vent line at position No. 7 was 2.310 inches in diameter. The drawing dimensions were 2.22 to 2.23 inches.	The aft skirt was accepted for use.
A270652 4-18-68	During installation of the LOX valve, it was noted that the LOX tank tee assembly, P/N 1B69768-1, had a gouge in the outer seal area approximately 1/2 inch long by 1/32 inch deep.	The openings of the tee assembly were capped to prevent contamination, and the gouge was smoothed out per DPS 40160. The reworked area was alodined per DPS 41410.
A270653 4-20-68	This was an Engineering requested FARR and documented the following discrepancies:	
	a. The aft battery simulator, P/N 1B65416-1, S/N 00002, was indicating a high temperature of 203°F. The indicated temperature should have been 75 ±12°F.	a. The battery simulator was accepted for use during the static firing. Postfire trouble shooting revealed a broken wire terminal on a temperature sensor.
	b. The output on pins H and G of receptacle J2 on the battery simulator was measured at 5.266 vdc. The output should have been 1.9 vdc.	b. The wire was reconnected, and operation of the simulator was verified per 1B65020 and was accepted by Engineering for use.
A270656 4-23-68	During poststorage checkout, it was noted that the LH_2 fill and drain valve, P/N 1A48240-505-007, S/N 0135, had intermittent talkback in the closed position.	The fill and drain valve was removed and replaced.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A270657 4-24-68	The following discrepancies were noted during the propulsion system leak check procedure: a. A bubble leak at seal, P/N AR10205-040, between stage skin and the nonpropulsive vent ducts, P/N 1B69220-1 and 1B69223-1. b. A fuzz leak at the blanking flange installation on the nonpropulsive vent exit at fin plane No. 3. c. A fast bubble leak from the top and bottom of the doubler mount and stage skin at fin plane No. 3. d. A light fuzz leak at the nonpropulsive vent mount flange to stage skin internal LOX vent. e. A fast bubble leak at the top and bottom of the nonpropulsive vent doubler and stage skin external.	Three rework attempts were required before satisfactory elimination of all documented leaks was accomplished.
A270658 4-25-68	Due to incorrect fabrication, the pipe assembly, P/N 1B70202-1, would not fit the stage.	The pipe assembly was removed and replaced.
A270660 4-25-68	During an Engineering run of the propellant loading procedure, it was noted that the LH_2 fill and drain valve, P/N 1A48240-505-007, S/N 0127, had no open talkback.	The talkback microswitch was adjusted in place.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A270665 4-30-68	During performance of stage power setup, the digital data assembly, P/N 1A74049-511, S/N 016, indicated a possible intermittent condition.	The DDAS assembly was removed and replaced.
A270666 5-1-68	During the performance of digital data acquisition system procedure, the high calibration measurement for the DDAS amplifier, P/N 1A82395-1, S/N 2317, was 4.076 vdc. The output should have been 4.00 $\pm$0.075 vdc.	The amplifier was removed and routed to the calibration lab for repair. After rework, the unit was reinstalled on the stage.
A270667 5-2-68	During the performance of DDAS automatic checkout, measurement D225, transducer assembly, P/N 1B40242-561-003, S/N 561-7, would not go into low RAC calibration. This condition occurred intermittently. During IST, the measurement remained in low RAC and would not return to ambient. A special test was performed but failed to isolate the cause of the discrepancy in the transducer assembly or channel decoder, reference FARR A270672, P/N 1A74053-503, S/N 351.	The transducer assembly was removed and replaced.
A270668 5-6-68	During the coldflow test TR1050, the output of measurement D248, transducer, P/N 1B40242-583, S/N 583-25, suddenly dropped to 800 psia and was noisy. The pressure at the time was verified to be 1400 psia.	The transducer was removed and replaced.
A270669 5-6-68	During inspection surveillance, it was noted that pipe assembly, P/N 1B70202-1, had a ding in the outboard side.	The pipe assembly was removed and replaced.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A270672 5-10-68	During the performance of DDAS automatic checkout, measurement D225 would not go into low RAC calibration. This condition occurred intermittently. During IST, the measurement remained in low RAC and would not return to ambient. A special test was performed, but failed to isolate the cause of the discrepancy in the transducer or the channel decoder, P/N 1A74053-503, S/N 351.	The channel decoder was removed and replaced.
A270673 5-13-68	During routine inspection surveillance, a discoloration of the painted surface was noted on the impingement curtain, P/N 1B65110-517,and -521, attach flanges above the thrust structure stringers 22 1/4 thru 23 1/4.	The discolored area was stripped of paint and primer, then cleaned with MEK. After the area was realodined per DPS 41410, primer, DPM 2232 was applied per finish specification F289.
A270674 5-14-68	During performance of IST, an attempt was made to check out the O_2H_2 burner sparks system that resulted in a failure of spark system 1. System 1 did not indicate ON in the alloted time. System 2 operated normally during the test. The fault was isolated as possible contact contamination of the 2 amp relay module, P/N 1A74211-509, S/N 0629.	The relay module was removed and replaced.
A270675 5-15-68	After replacement of transducer kit, P/N 1B40242-561-003, S/N 561-7, per FARR A270667, with S/N 561-3, the installation was checked out and would not respond when high and low calibration and run mode commands were sent. During trouble shooting,	The transducer kit was removed from the stage and replaced.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A270675 (Cont.)	it was found that the two plugs on the dc amplifier were interchanged. This applied 28 vdc improperly to the amplifier, resulting in permanent damage to the amplifier.	
500-025-361 2-12-68	The following discrepancies were noted during postfire checkout: a. The entire aft skirt area ablative coating was out-of-tolerance. The paint thickness varied from 0.007 to 0.026 inches. Blueprint specifications were expressed as 0.010 +0.005 -000 inches. b. The forward skirt ablative coating was out-of-tolerance. The paint thickness varied from 0.0065 to 0.025 inches. Blueprint specifications were 0.010 +0.005 -000 inches.	The stage ablative coating was accepted for use.
500-025-425 2-16-68	During performance of LH_2 tank horizontal inspection procedure, it was noted that the LH_2 tank manhole flange, P/N 1B63182-1, was discolored with a hard black undetermined material. The discoloration appeared as small pit marks.	The black discoloration was removed with craytex rods. After rework, the flange was wiped clean with isopropyl alcohol, then all bare spots were alodined.
500-025-760 2-20-68	During postfire structural inspection, it was noted that the silicone paint thickness on the forward and aft skirt areas varied from 0.0035 to 0.024 inches. The paint thickness should have been 0.004 to 0.008 inches.	Additional paint was added to areas that were under minimum specifications. All other areas were accepted by Engineering.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-026-120 3-15-68	The following discrepancies were noted during rework per AO 1B66981-1:	
	a. Cannon connector, reference location 411A99A10W1P40, on cable assembly, P/N 1B66969-1, had female connectors A, E, K, S, D, G, R, f, e, m, r, p, n, and s misaligned with the insert.	a. The nylon inserts were removed from the connector, and the pins were re-aligned. The connector was flushed with isopropyl alcohol, purged with GN_2, then reassembled.
	b. The mating receptacle on module, P/N 1A74218-509, S/N 0621, showed superficial plating damage to the male contacts. Moisture was found in the receptacle.	b. The module was removed from the stage, and the receptacle flushed with isopropyl alcohol and purged with GN_2. The plating damage was accepted, and the module was reinstalled on the stage.
500-026-138 3-18-68	The following discrepancies were noted during rework per AO 1B66970-1:	
	a. Wire No. M319A2 of the 403W7, P/N 1B66970-1, had insulation damage near the 404A3 panel.	a & b. The damaged wires were removed and replaced.
	b. Wires No. 20M417A22 and 4029A22 in cable assembly, P/N 1B66970-1, had insulation flattened and malformed. Damage was at the clamp above the 404A70 panel.	
500-026-146 3-22-68	During rework on the LOX vent and relief valve, P/N 1A48312-505, S/N 0022, the following discrepancies were noted:	

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-026-146 (Cont.)	a. The retaining pin on receptacle J1 was loose.	a. The loose retaining pin was accepted for use.
	b. The leak check of the valve could not be accomplished due to improper leak check adapter seal.	b. RTV-731 sealant was applied over the loose retaining pin on the inside of the connector. After leak check of the valve, the sealant was removed.
500-026-154 3-22-68	During installation of the module, P/N 1A58345-519, in reference location 403A1, it was noted that a mounting stud on the mounting assembly, P/N 1B53114-507, was cracked and bent.	The isolator, P/N 91076-4, was removed and replaced on the mounting assembly.
500-026-162 3-22-68	During surveillance of LH_2 tank components, it was noted that pipe assembly, P/N 1B58657-527, S/N 00118, had a sharp bend where the pipe clamps attached to stringer 100.	The pipe assembly was removed and replaced.
500-026-171 3-22-68	Wire No. D1410C22 of cable assembly, P/N 1B58326-1, S/N 7727, was found to be cut through the insulation, exposing bare wire with copper showing. The damaged area was on wire support panel, P/N 1B62906-13, reference location 403A11W201.	The damaged wire was removed and replaced.
500-026-189 3-26-68	The following discrepancies were noted during installation of pipe assemblies:	
	a. Bracket, P/N 1B37207-11, on thrust structure stringer 11A, was located 12 3/4 inches below the heel line of the thrust structure. The bracket should have been 11 25/32 inches below the heel line.	a. The bracket on stringer 11A was relocated 12 inches from the heel line to pick up existing open hole on the stringer.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-026-189 (Cont.)	b. Bracket, P/N 1B37207-11, on stringer 12 was located 13 3/4 inches below the heel line and should have been 12 3/4 inches below the heel line.	b. The bracket on stringer 12 was relocated per blueprint specifications.
500-026-197 3-28-68	During the performance of electrical resistance tests, the following discrepancies were noted with the LH_2 fill and drain valve, P/N 1A48240-505, S/N 0045: a. With the valve open and 50 vdc applied, the electrical resistance between pins D and F was 3 megohms. The resistance should have been 50 megohms. b. With the valve closed and 50 vdc applied, the electrical resistance was as follows: 1. Pins d and E - 13 megohms 2. Pins $\overline{D}$ and F - 8 megohms 3. Pins E and F - 25 megohms The minimum resistance required was 50 megohms.	The valve was removed from the stage and replaced.
500-026-201 4-2-68	During surveillance inspection, it was noted that two isolators, P/N 1B32258-1, S/N's 212 and 213, had loose lower retainers that prevented tightening the corresponding panel hold-down bolt to the required torque value.	The isolators were removed and replaced.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-026-821 6-7-68	During the performance of the open loop PCM transmission section of AST, it was noted that the amplifier output voltage mounting transducer, M60, of the propellant utilization electronics assembly, P/N 1A59358-525, S/N 022, was noisy. The noise amplitude varied between 0 and 30 vdc.	The propellant utilization electronics assembly was removed and replaced. Retest was accomplished per the PU calibration manual and PU automatic checkout procedures.
500-026-863 6-25-68	During data evaluation, it was noted that the event switch selector output monitor had a pulse magnitude varying between 0.5 vdc to 1.7 vdc when the cutoff bus was turned off.	It was determined that the condition did not present an operation problem, and it was acceptable to the Material Review Board.
500-162-970 4-15-68	During the fit check prior to final welding, it was noted that pipe assembly, P/N 1B68897-1, would not fit the stage.	The spiral tape wrap was removed from the tube assembly and a 3/8 inch section was removed; then, the tube assembly was tack welded. The tube assembly would not fit the stage after the noted rework, and it was removed from the stage. A new tube assembly was fabricated and installed on the stage.
500-163-500 4-18-68	During a production acceptance test on the fill and drain valve, P/N 1A48240-505, S/N 0127, the glass insert of the electrical connector was found to be cracked between the pins.	After completion of the production acceptance test and a leak check, the valve was accepted for use.
500-225-157 7-2-68	The LH_2 chilldown shutoff valve, P/N 1A49965-523, S/N 0506, had walnut hulls inside the transducer mounting ports. NOTE: Walnut hulls were used to remove the stage ablative coating in preparation for the repainting of the stage.	After determining that the contamination was confined to the conoseal areas, the conoseal areas were wiped with a LOX-clean cloth wetted with freon, then flushed with freon.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-225-220 7-24-68	During a special pull test, two isolators, P/N's 1B32256-1, one located on panel No. 15 between stringers 37 and 43, and one on panel No. 11 between stringers 55 and 61, were found to be debonded.	The discrepant isolators were removed and replaced.
500-225-271 6-12-68	During the performance of AST, an anomaly in the open loop transmission of the PCM data train was observed at the telemetry ground station. The observation indicated an intermittent "tearing" of the PCM data train. This visual discrepancy was noted on three separate ground stations and was verified at the data reduction laboratory from direct stage transmission. Investigation indicated that the power filter circuit in the PCM T/M transmitter, P/N 1B52721-521, S/N 034, was defective.	The PCM T/M transmitter was removed from the stage and replaced.
500-225-297 6-25-68	During the AST data evaluation, it was noted that 10 measurement parameters exhibited RFI susceptibility.	The condition was accepted by action of the Material Review Board.
500-225-866 8-2-68	During the performance of an inspection line check, plate assembly, P/N 1B59265-1, and adapter, P/N 1B59264-1, had not been installed per view AC-AC, zone 40 of 1A39322.	The installation of the plate assembly was accepted.
500-226-269 5-15-68	The following discrepancies were noted during an inspection line check: a. All drain holes in the aft attach angles, between stringers 42 to 112 and 1 to 14 were too small.	The stage was acceptable to the Material Review Board.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-269 (Cont.)	b. Portions of the aft skirt skin were found to be covering approximately 15 per cent of the drain holes at stringers 1, 4, 7, 10, 13, 19, 22, 25, 28, 37, 40, 64, and 111.	
	c. The drain holes between stringers 13-14 and 16-17 were filled with dynatherm coating.	
500-226-277 5-16-68	The following leaks were found on the J-2 engine, P/N 103826, S/N J-2091, during the engine leak check procedure:	
	a. A heavy fuzz leak between pipe assembly 389 and 390 in the "V" area at the exhaust manifold on the thrust chamber.	a & c. The conditions were acceptable to Engineering.
	b. A bubbling leak between pipe assembly 422 and 423, approximately 1 inch above the first hat band located above the exhaust manifold on the thrust chamber.	b. The joint between pipe assemblies 422 and 423 were re-brazed, and a leak check of the reworked area indicated no leakage.
	c. A bubbling leak at the seal leak check port between the injector and the thrust chamber manifold.	
500-226-285 5-17-68	During the performance of the propulsion system leak and functional test, it was noted that pipe assembly, P/N 1B58292-1, was bent approximately 15 degrees adjacent to the B-nut at the actuation port of the LH_2 shutoff valve.	The pipe assembly was removed and replaced.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-293 5-20-68	The thermocouple vacuum probe, P/N 665-18806, S/N 4045689, on the upper section of the LH_2 low pressure duct, gave erratic readings during checkout of the duct.	The thermocouple was removed and replaced.
500-226-307 5-20-68	During the performance of the hydraulic system automatic checkout on 14 May 1968, an out-of-tolerance condition was noted on NASA measurement D209. The indicated pressure was 35.02 psig, and the pressure indications at the time should have been 21 $\pm$12 psig. Investigation and Engineering tests indicated that the air pressure regulator, P/N 302073A, S/N 432J, mounted on the auxiliary hydraulic pump was the cause of the discrepancy.	The air pressure regulator was removed and replaced. A functional test of the hydraulic system was accepted.
500-226-315 5-22-68	During the propulsion systems automatic procedure, the mainstage OK pressure switch No. 1 gave an out-of-tolerance reading of 551.94 psia. The maximum should have been 551.00 psia.	The pressure switch was removed and replaced.
500-226-331 5-23-68	During the structural inspection postfire procedure, it was noted that two cap assemblies, P/N 1B42355-1, were missing from the forward end of stringers 29 and 30.	The cap assemblies were installed per blueprint specifications.
500-226-340 5-24-68	During postfire checkout, an inspection check revealed that the deletion of two wires in wire harness, location 404A2W1, per EO 1B67270-D and AO 1B67271-D, had not been accomplished.	The rework specified on EO 1B67270-D and AO 1B67271-D was accomplished.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-358 5-24-68	During the propulsion leak and functional check, the cold helium shutoff valves in the LOX pressure module were found to have a seat and pilot valve leakage of 55 scim. Cycling improved the leakage to 15 scim. The maximum leakage allowable was specified as 12.5 scim.	The LOX pressure module was removed from the stage and replaced.
500-226-366 5-27-68	During performance of the DDAS automatic procedure, NASA measurement C387 was observed to be out-of-tolerance. The high RAC output was 4.138 vdc and low RAC was 0.078 vdc. The high and low RAC outputs should have been 4.00 $\pm$.075 vdc and 0 $\pm$.075 vdc, respectively. Trouble shooting indicated the discrepancy was caused by a faulty analog submultiplexer, P/N 1B54062-505, S/N 040.	The submultiplexer was removed and replaced.
500-226-374 5-27-68	The following discrepancies were recapped from the propulsion system leak and functional procedure:	
	a. Reference paragraph 4.11.3, step 5, and IIS 384048, item 7, the cold helium shutoff valve seat and pilot valve leakage was 53 scim. The maximum allowable was 33 to 49 scim.	a. The module, P/N 1B42290-505, was removed and replaced with a -507, per EO 1B58006-AT.
	b. Reference paragraph 4.12.5, step 5, the LOX chilldown pump purge flow was 52 scim. The flow rate should have been 33 to 49 scim.	b. The module, P/N 1A58347-505, was removed and replaced.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-374 (Cont.)	c. Reference paragraph 4.12.1. and 4.18.3.1, blacklight inspection of the injector and chamber throat area tubes of the J-2 engine showed evidence of grease contamination.	c. The J-2 engine was acceptable to Engineering.
	d. Reference leak check log item 6 and paragraph 4.7.9.68, the LOX prevalve pneumatic adapter had a small fuzz leak.	d, e, & f. The conditions were acceptable to Engineering for use. NOTE: Items d & e were leak checked per 1B71877.
	e. Reference leak check log item 7 and paragraph 4.7.9.68.1, the LOX prevalve had a rapid bubble leak at the microswitch housing.	
	f. Reference procedure revision 41, the LOX nonpropulsive vent blank flange at fin line 3 had a blowing leak.	
500-226-382 5-29-68	During postfire checkout, it was noted that the output of the 20 volt excitation module, P/N 1A74036-1, S/N 0310, was 18 vdc. The output was adjusted to the required 20 vdc, but the output drifted back to 18 vdc.	The module was removed from the stage and replaced.
500-226-455 6-3-68	The LH_2 propellant duct, P/N 1B49320-509-006, S/N 30, was found to have a 1/2 inch by 1/4 inch wide by 0.040 inch deep ding in the upper section of the duct approximately 18 inches from the joining section of the upper and lower ends.	The LH_2 duct was accepted by the Material Review Board.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-471 6-4-68	During routine inspection surveillance, it was noted that the bleeder plug, P/N 1B27980-501, on the auxiliary hydraulic pump was broken.	The plug was removed and replaced.
500-226-480 6-7-68	The following discrepancies were documented on IIS 384034 during the performance of the postfire structural inspection:	
	a. The koratherm covering between stringers 13 and 14, just above the forward skirt aft attach ring, was cracked and loose.	a thru f. The koratherm coating in the affected areas was removed per DPS 42105 and reapplied per DPS 42210.
	b. A 2 by 5 inch section of koratherm was missing between stringers 14 and 15, 3 inches above the aft attach ring on the forward skirt.	
	c. The koratherm between stringers 14 and 15 was cracked approximately 24 inches above the aft attach ring on the forward skirt.	
	d. A 3 by 5 inch section of koratherm was missing between stringers 17 and 18, approximately 24 inches above the aft ring on the forward skirt.	
	e. A section of koratherm approximately 2 inches in diameter, was missing between stringers 17 and 18, 2 inches above the aft ring of the forward skirt.	

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-226-480 (Cont.)	f. The koratherm between stringers 12 and 18, approximately 20 to 24 inches above the aft ring of the forward skirt was cracked and loose.	
	g. The white paint on the LH_2 tank exterior, approximately 8 inches above the LH_2 chilldown fairing was found to be peeling.	g. The area above the chilldown fairing was stripped down to the bare metal and refinished per finish specification F-289.
	h. The upper conoseal clamp on the LH_2 fill and drain valve was nicked, filed, and the exterior surface had been removed.	h. All sharp edges of the conoseal clamp were smoothed out, and the resultant bare metal surfaces were brush coated with alodine per DPS 41410.
500-226-501 6-7-68	During the propulsion system leak and functional check, it was noted that the LOX tank vent and relief purge hand valve leaked past the seat in the closed position.	The hand valve was removed from the stage and replaced.
500-372-249 8-9-68	During inspection of the forward signal conditioning rack assembly, P/N 1B55689-505, S/N 010, the following discrepancies were noted:	All of the discrepant supports were removed and replaced.
	a. One support, P/N 1B57776-13, was broken off the rack assembly at the base.	
	b. Six supports, P/N 1B37428-511, were delaminated at the base.	
	c. One support, P/N 1B37428-513, was delaminated at the base.	

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-372-516 8-13-68	During the attempted installation of the actuation control module support, P/N 1B75295, it was noted that the support could not be installed due to an adverse accumulation of tolerances when the web, P/N 1B75295-5 and -7, were installed on the support.	The piloted tees were removed, and unpiloted tees were installed on the web. Installation of the support was then accomplished.
500-372-524 8-14-68	During modification to the O_2H_2 burner assembly, it was noted that the pipe assembly, P/N 1B62600-31, was too short.	The pipe assembly was removed and replaced.
500-372-532 8-16-68	During rework per AO 1B64174-Z, it was noted that the threads on the wire bundle support, P/N 1B31244-531, on the panel, P/N 1A88924-507, were stripped.	The damaged threads were drilled out, and a keensert was installed per 1B53312.
500-372-541 8-16-68	It was noted that pipe assembly, P/N 1B75031-1, was 1/2 inch too long to be installed, and the contour was not correct.	The tube assembly was removed and replaced.
500-372-559 8-16-68	The pipe assembly, P/N 1B75032-1, was found to be 1/2 inch too long.	The excess length was removed, and the pipe assembly was re-flared.
500-372-567 8-19-68	Wire No. K676B20, in wire harness, P/N 1B74873, was found to have been cut through; and the blue and white wires showed signs of being nicked (insulation damage only). The area of damage was at stringer 1A in the thrust structure.	The cut wire was removed and replaced. The blue and white wires were repaired with fusible teflon tape per DPS 54010.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-372-575 8-22-68	During rework per AO 1B55906-AK, it was noted that doubler, P/N 1B55906-15, was installed between stringers 66 and 67. The doubler plate should have been installed between stringers 108 and 109.	The doubler plate was removed from the stage, and a new doubler was fabricated and installed in the proper location.
500-372-605 8-23-68	Two bonded supports, P/N 1B37889-535, on the exterior LOX dome weld seam No. 1, were found to have been mislocated.	The supports were removed and relocated per blueprint specifications. The mylar covering in the reworked areas was replaced per DPS 22301.
500-372-613 8-27-68	The doubler plate, P/N 1A81860-23, was found to have been mislocated.	A new doubler plate was fabricated and installed on the stage.
500-372-621 8-27-68	During the performance of an inspection line check, the pipe assembly, P/N 1B43397-1, was found to have a ding in the convolution of the flex section approximately 12 inches from the bottom of the flex section. NOTE: The wire braid that covered the flex section made it impossible to determine the severity of the damage.	The pipe assembly was removed and replaced.
500-372-630 8-27-68	The following discrepancies were noted on the fuel feed duct assembly, P/N 1A49320-509-006, S/N 30, during an inspection line check: a. A 1/4 inch long by 1/8 inch deep ding in the duct, located on the 10th convolution ring from the top of the duct, to the left of the weld seam looking inboard.	The fuel feed duct was accepted for use.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-372-630 (Cont.)	b. A slight ding in the 4th convolution ring from the top, approximately 90 degrees from the weld seam looking inboard.	
	c. Several small dings in the 5th, 6th, 7th, 9th, and 11th convolutions from the top, approximately 90 degrees from the weld seam, on the left side looking inboard.	
	d. A ding, 3/8 inch long by 1/16 inch deep, in the 11th convolution from the bottom of the duct, 3 inches to the left of the weld seam looking inboard.	
	e. A 1/4 inch long by 3/8 inch deep ding between the 25th and 26th convolutions, 110 degrees inboard of the weld seam.	
	f. Several minor dings in the convolutions just inside of the aft skirt. The depth of the dings could not be measured due to inaccessability.	
500-372-648 8-28-68	During installation of the doubler, P/N 1A81860-23, the following discrepancies were noted:	The doubler was removed from the stage and reworked as follows:
	a. A 0.014 inch diameter hole in the doubler was mislocated by 1 inch.	a. The mislocated hole was flush plugged with AD rivet material. A new hole was drilled in the correct location.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-372-648 (Cont.)	b. The edge distance of the top and bottom row of rivets was 5/16 inch. The edge distance should have been 9/16 inch.	b. The rivets were removed, and a new attachment was installed per blueprint specifications. After acceptance of the rework, the doubler was reinstalled on the stage.
500-372-656 8-26-68	During installation of the mounting block, P/N 1B76026-1, it was noted that the block was not fabricated to the required dimensions of 0.75 by 0.75 by 2.75 inches. The block measured 0.75 by 0.98 by 2.75 inches.	The excess thickness was cut off, and the block was brought the correct dimensions.
500-372-664 8-29-68	During installation of the J-2 engine on the stage, two dings were found on the block of the fitting assembly, P/N 1A57487. The dings measured 1/4 inch long by 1/2 inch wide by 0.01 inch deep.	The protrusions around the dings were feathered, and the reworked areas were touched up per DPS 41410.
500-372-672 8-30-68	The 427MT707, 427MT710, and 427MT684 strain gauges were found to be debonded in the aft skirt.	New strain gauges were installed per DPS 30151. Mechanical pressure as well as vacuum bag pressure was used to obtain adequate bonding.
500-372-681 8-30-68	During inspection of rework in an adjacent area, it was noted that wire P1006A22 in wire harness, P/N 1B68321, had damaged insulation approximately 6 inches from 406A64W200P41.	The noted wire was removed and replaced. The wire harness was retested per 1B67824.
500-372-699 9-3-68	During installation of strain gauges, P/N SA13-125TA-120, on the aft skirt, the following discrepancies were noted:	All the debonded strain gauges and terminal boards were removed. New parts were installed, using mechanical pressure as well as vacuum bag pressure to ensure adequate bonding.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-372-699 (Cont.)	a. The 427MT709, 427MT708, and 427MT683 strain gauges were debonded. b. Terminal strips at locations 427MT707, 427MT710, and 427MT638, were debonded. There were six other terminal strips on stringers 18 and 132 that were debonded.	
500-372-702 9-4-68	During progressive inspection of rework, wire No. M14AB22 of the 404W7 wire harness, P/N 1B75984, was found to be nicked approximately 8 inches from P6.	The damaged wire was repaired per DPS 54010.
500-372-711 9-5-68	During installation of the repressurization spheres, it was noted that the following pressure transducers, P/N 1B39293-517, had no protective covering over the B-nut end and were considered to be contaminated: a. S/N 260, 403MT638 b. S/N 261, 403MT639	The transducers were removed from the stage, routed to the calibration laboratory for cleaning and testing, and were reinstalled on the stage.
500-372-729 9-12-68	During installation of an adapter plate, it was noted that a nut, P/N 1B28715, located approximately 10 1/2 inches from the lower right edge of the thermoconditioning panel, P/N 1A98146-515, S/N 00284, and 2 1/2 inches from the bottom of the panel was unbonded and partially removed.	A new nut was installed on the panel per General Note 3 of 1A98146-515.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-372-737 9-13-68	During removal of the LOX probe, a brown residue was found in the LOX probe port.	The LOX probe port was wiped clean with demineralized water and freon. A slight amount of stain could not be removed. Investigation revealed that the stain was alodine and was acceptable to Engineering.
500-372-753 9-25-68	a. This rejection was due to an Engineering request based on failures of similar valve installation during qualification testing. 1. The fuel fill and drain, P/N 1A48240-505, S/N 0127, mounting bolt and bushings were not installed per blueprint. 2. Bushing, P/N S0728-4-194, had a damaged shoulder. b. Per resubmit, the valve was dimensionally checked as follows: 1. The $2.000 \pm^{0.000}_{0.010}$ inches dimension across the mounting lugs was 1.996 inches. 2. The $2.000 \pm^{0.000}_{0.010}$ inches dimension between flange supports was 2.010 inches. 3. The gap between the end of the bushings was zero (0).	A dimensional check was made of the mounting lugs between the flange supports, the gap between bushing ends, and the breakaway torque. The mounting lugs were dye penetrant checked for cracks. The valve was reinstalled using new bushings, P/N 50728-4-28; nuts; a conoseal gasket; and leak checks per 1B71877. The valve was functionally checked per 1B62753.

TABLE III (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-372-753 (Cont.)	4. The breakaway torque was recorded at 60 inch pounds.	
	5. The dimension between the flange supports was reverified and found to be the same as in item 2 above.	
	6. The dye penetrant check of the mounting lugs revealed that no cracks existed.	

TABLE IV. FAILURE AND REJECTION REPORTS
POST MODIFICATION RETEST

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-370-904 10-25-68	During installation per 1B58006BG, zone 53, view A-A, it was noted that the pipe assembly, P/N 1B76429-1-001, had an insufficient bend radius, causing a misalignment of approximately 3/4 inch with the associated fitting.	The pipe assembly was removed and replaced. The sleeves and B-nuts were used in the fabrication of a new pipe assembly.
500-370-939 10-28-68	During installation per 1B58006BC, zone 53, it was noted that pipe assembly, P/N 1B75965-1, was approximately 0.300 inches too long, causing a misalignement when connected to the cross on pipe assembly, P/N 1B62807-1.	The pipe assembly was removed, and a new pipe assembly was fabricated and welded to the 1B64251-1 fitting. The weld was inspected, tested, wrapped, cleaned, and packaged per P/N 1B75965, and reinstalled on the stage.
500-373-512 11-12-68	During rework per 1A88852-A45-1, it was noted that the transducer assembly, P/N 1A88852-505, S/N 5570, had galled threads in the calibration adjustment screw hole. A hole was drilled through the set screw to facilitate adjustment.	The damaged set screw threads were acceptable to the Material Review Board. After adjustment per 1A88852-A45-1, the set screw hole was filled with anti-tamper compound, omitting the set screw.
500-488-115 11-25-68	During internal inspection of the LH_2 tank, the following discrepancies were noted: a. There was foreign material on the cold helium bottles at positions 1, 5, 7, and 8. b. The diffuser sock, P/N 1B65813-1, was discolored.	Both conditions were acceptable to the Material Review Board.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-488-123 11-27-68	During the performance of the FM/FM and SSB system procedure, it was noted that the T/M calibrator, P/N 1B76202-1, S/N 6800195, was discrepant and would not respond to the correct inflight calibration signal.	The T/M calibrator was removed from the stage. The replacement part is to be installed at FTC.
500-488-131 11-27-68	During rework per 1A39300-509, it was noted that the koratherm was cracked approximately 1 inch by 4 inches adjacent to stringer 119, and 8 inches forward of the fuel chilldown pump at the left side of the fairing mount.	The disposition was given to resubmit the condition to the FTC Material Review Board for further action.
500-488-298 11-12-68	During rework per FO 6690203 and 1B70422, paragraph 4.24.26, the check valve, P/N 1B67481-1, S/N 8011521, cracking pressure was 4.6 psi. The cracking pressure should have been less than 4 psi.	The check valve was removed and replaced.
500-489-260 10-31-68	During performance of AO 1B58006BJ, the 405MT607 temperature probe, P/N 1B34473-505, S/N 310, was bent approximately 3/4 inch from the tip of the probe.	The temperature probe was removed and replaced.
500-489-278 11-1-68	During removal of the coining clamp from the duct assembly, P/N 1A94469-511, and valve, P/N 1A48257-525, it was noted that the gasket, P/N 55600-600AJ was damaged. The seating area and outer flange of the valve and duct were damaged. The area was subjected to possible contamination due to metal shavings from the gasket.	The gasket was removed and replaced. The outer flange area of the valve was polished, and the reworked area was treated with alodine 1200, maintaining cleanliness per DPS 43150. The system was leak checked per 1B71877.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-286 11-5-68	During leak check per 1B71877, the LOX prevalve, P/N 1A49968-521, S/N 105, leaked internally at 2796 scims, which exceeded the maximum of 150 scims.	The prevalve was removed and replaced.
500-489-308 11-7-68	During an inspection line check, it was noted that the O_2H_2 burner, P/N 1B62600-527-012, S/N 08, had bolts, P/N NAS1004-9A, installed in nozzle assembly, P/N 1B63780-1E. These bolts should have been P/N NAS1004-13A. Also, improper nuts were used for attachment.	The bolts, nuts, and washers were removed, and proper hardware was installed per 1B62600 and 1B63780 drawings.
500-489-316 11-7-68	During checkout per 1B64681-G, the 404A67A225 strain bridge module, P/N 1B68859-503, S/N 049, would not indicate a reading lower than 0.060 vdc, and should have been 0.000 $\pm$0.005 vdc.	The module was removed and replaced.
500-489-324 11-8-68	During strain gauge installation, it was noted that excessive ablative coating was removed at the following areas: a. At the forward interstage, between stringers 68 and 69, 14, 15, 26, 27, and 28. b. At the aft interstage between stringers 38 and 39 and 132 and 133.	The areas were reworked per instructions on 1A39301-A45-2.
500-489-332 11-9-68	During the performance of DDAS, the pressure transducer, P/N 1B40242-571, S/N 511-2, had no output when high and low RACS were given or when the run mode command was given for an ambient reading.	The transducer was removed and replaced.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-341 11-11-68	It was noted per 1B49196, that the O_2H_2 burner LH_2 propellant duct, upper section, P/N 1B65206-503, indicated 1000 microns and should have been less than 250 microns. On resubmit, the readings every 24 hours for 5 days ranged from 1000 to 20 microns. After recertification of the vacuum meter, the duct had a reading of 45 microns.	The duct was verified for a 12-hour period, then once every 24 hours for 5 days and resubmitted. The pins of the probe were cleaned with isopropyl alcohol. The vacuum meter was sent to the lab for recalibration and repair. The duct was accepted by the Material Review Board for use.
500-489-359 11-11-68	During performance of 1B73601, the 411W207 cable, P/N 1B58361-1, S/N 9848-2, at the 411E200J1 TM antenna No. 1, had a pin extracted from the P2 coaxial connector.	The pin was reterminated and tested per 1B73601.
500-489-367 11-12-68	During performance of DDAS procedure 1B55817, it was noted that the 411MT604 forward internal static pressure transducer, P/N 1A68551-1, S/N 369-1, measurement No. D0051, had a reading of 14.353 psia and should have been 14.7 $\pm$0.3 psia.	The transducer was removed and replaced.
500-489-375 11-13-68	During rework in an adjacent area, it was noted that the coaxial cable, P/N 1A68707-63, had a broken connector at the 401MT725 accelerometer, part of transducer kit, P/N 1A68707-649, S/N 5594.	The transducer kit was removed. The installation, test, and operation was transferred as open items on the stage turnover and will be completed at FTC.
500-489-383 11-13-68	During the range safety receiver check, the secure command receiver, P/N 50M10697, S/N 166, bandwidth test response was questionable. The data appeared to be random at several frequency deviations. The bandwidth requirements were acceptable, but a point-to-point frequency to signal strength plot	The unit was removed and replaced.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-383 (Cont.)	indicated a number of peaks and valleys. The plot should have rolled off at a linear rate.	
500-489-405 11-13-68	During rework in an adjacent area, it was noted that the coaxial cable, P/N 1A68707-63, had a broken connector at the 401MT740 accelerometer, part of transducer kit, P/N 1A68707-653, S/N 5588.	The transducer kit was removed. The installation, test, and operation was transferred as open items on the stage turnover and will be completed at FTC.
500-489-413 11-13-68	During rework in the adjacent area, it was noted that the coaxial cable, P/N 1A68707-63, had a broken connector at the 401MT655 accelerometer, part of transducer kit, P/N 1A68707-651, S/N 5568.	The transducer kit was removed and replaced.
500-489-421 11-14-68	During performance of leak checks per 1B71877A, it was noted that the pneumatic actuation latch, P/N 1B66639-515, S/N 045, had a leak approximately 20 and 30 scim between the bellows and the body assembly and through the bellows bleed port. The system was pressurized at 500 psig with no leakage allowed.	The assembly was removed and replaced.
500-489-430 11-14-68	During inspection of the area, it was noted that support, P/N 1B31245-513, on the forward center of panel, P/N 1B53666-547, and panel, P/N 1B53666-545, at stringer 69 and between stringers 83 and 84, had stripped threads.	The supports had inserts installed per 1B53312.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-448 11-16-68	During performance of single sideband per 1B73601, the 411A64A210 RF Model II transmitter, P/N 1B52721-511, S/N 020, had a power output of 33.5 watts and should have been less than 26.73 watts.	The transmitter was removed. The replacement part will be installed at FTC.
500-489-456 11-16-68	During performance of single sideband per 1B73601, the 411A98A204 RF Model II transmitter, P/N 1B52721-517, S/N 006, had a power output of 28.5 watts and should have been less than 26.73 watts.	The transmitter was removed. The replacement part will be installed at FTC.
500-489-481 11-15-68	a. During routine inspection, it was noted that the heat impingement curtain cloth segment, P/N 1B65607-1B, S/N 011, at stringer 20 in the 404 aft skirt, had a cut approximately 2 inches long. There was also a 1 1/2 inch tear in the curtain, at the LH_2 chilldown return line, in two different locations.	a. Doublers of at least one inch larger than the noted cuts were bonded and sewed per drawing requirements.
	b. The latex finish was damaged in several places.	b. The damaged areas were wiped with toluene and air dried for one hour minimum. A layer of 1P20014 adhesive 1/32 inch thick was applied and allowed to dry for 24 hours undisturbed.
500-489-499 11-16-68	a. During performance of 1B73601, it was noted that the 404W207 cable, P/N 1B76000-1, had a punctured insert between pin E and the shell of connector P50.	a. The connector insert damage was accepted by the Material Review Board.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-499 (Cont.)	b. Pin E of receptacle J2 on the 404MT735B amplifier, P/N 1A88852-503, S/N 318, at the 404A70 panel, was bent approximately 40°.	b. The pin was straightened with a type 555 pin straightener. NOTE: The system will be functionally checked per 1B73601 at FTC.
500-489-502 11-26-68	a. During performance of 1B64681, it was noted that pin N of the J1 receptacle on the 404A68A203 module, P/N 1A84763 -511, S/N 0151, was bent.	a. The pin was straightened with a type 555 pin straightened.
	b. The 404A68A203 cable, P/N 1B76206-1, had a punctured insert adjacent to socket N of connector P3.	b. The damaged connector was removed and replaced. NOTE: The system will be functionally checked per 1B73601 at FTC.
500-489-529 11-8-68	The threaded insert in fastener, P/N 1B28715-1, was missing from the 411A92 forward skirt thermoconditioning panel, P/N 1A98142-501, S/N 0027. The missing insert was approximately 18 inches forward and 20 3/16 inches from the left side of the panel.	The insert was replaced and bonded per 1A98142.
500-489-537 11-15-68	The curtain assembly, P/N 1B69815-A45-3-9, was not reworked to the A45-3 change. Per 1B65607, zone 4, the main view dimension was approximately 89.00 and should have been 90.89. The main view dimension per zone 5 is approximately 66.00 and should have been 67.77.	The curtain assembly was removed and replaced.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-570 11-18-68	During performance of 1A39300, job 13, per 1A39322, zone M, view C-C, it was noted that the insulation, P/N 9709132, was debonded from the LH_2 duct, P/N 1A39301, at the end over the LH_2 prevalve.	The damaged insulation was acceptable to the Material Review Board.
500-489-561 11-18-68	During system check, it was noted that the J-4 receptacle on the range safety decoder had the following defects: a. One pin was bent 90 degrees. b. One pin was bent 45 degrees and was shorting an adjacent pin which was bent 30 degrees. c. Four pins were slightly bent. NOTE: The above pins were not identified by letter or number.	The decoder was removed and replaced.
500-489-588 11-19-68	a. During rework per 1B75982-1, it was noted that the P28 connector insert of cable, P/N 1B75982-1, at the 404A3 sequencer, was punctured between a, s, and T, adjacent to DD.	a. The connector was removed and replaced.
	b. Pin t of receptacle J28, at the 404A3 sequencer, was bent.	b. The bent pin in receptacle J28 was straightened per DPS 54002. NOTE: The system will be functionally checked at FTC.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-596 11-18-68	During routine inspection per 1B58006, zone 3, view AV-AV, the pipe assembly, P/N 1B76051-1, was distorted and bent at the adapter, P/N MC237C4W, end.	The pipe assembly was removed and replaced.
500-489-600 11-20-68	During rework per 1B75982-1J, it was noted that the retainer ring for the rubber insert at connector P42 of cable assembly, P/N 1B75982-1, was bent and distorted between the two guide pins.	The condition was acceptable to the Material Review Board for use.
500-489-618 11-20-68	During performance of 1B41005, paragraph 4.2.1.4, it was noted that both the pitch and yaw actuator shafts had numerous small scratches and dents in the midstroke lock grooves.	The scratches were smoothed and polished out. The dents were acceptable to the Material Review Board.
500-489-626 11-20-68	During performance of 1B73601, it was noted that parameters E211 and E225 of the channel calibration decoder, P/N 1A74053-503, S/N 115, at the 404A71A206 panel, failed to receive remote automatic calibration.	The decoder was removed and replaced. NOTE: The system will be functionally checked per 1B62753 at FTC.
500-489-634 11-20-68	During performance of 1B73601, paragraph 4.1.69, it was noted that the 411A60A203 vibration multiplexer, P/N 1B32686-509 S/N 02, measurement No. S102 through S107, had no output.	The vibration multiplexer was removed. The disposition was given to resubmit the condition at FTC Material Review Board for further action.
500-489-642 11-20-68	During rework of 1A75985-1E, it was noted that the 411A99A10W1 cable, P/N 1B75985-1E, had a wire, R221A20, with a 1/8 inch split in the insulation exposing the wire strands just aft of connector P52 backshell.	The wire was removed, replaced, and tested per 1B75985.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-489-669 11-21-68	During preshipment inspection, it was noted that 17 nyafil standoffs in the thrust structure, aft skirt, and main tunnel areas had stripped threads.	The inserts were removed and replaced per 1B53312.
500-489-693 11-21-68	During performance of 1B73601, it was noted that the 401MT664A vibration combustion dome measurement No. E251 was 0 vpp and should have been 1.4 $\pm$0.5 vpp.	The disposition was given to resubmit the condition at FTC Material Review Board for further action.
500-489-723 11-22-68	During the final inspection, the following discrepancies were noted:	
	a. There was insufficient clearance between the convolutions of the continuous vent duct, P/N 1B44575-502, between stringers 95 and 103.	a. The attach and securing bolts for the continuous vent duct were released, and the flex elbow was rotated to relieve the preload. Two 6061-T6 shims were added between the duct and the mounting clamp at stringer 103. The mounting holes at stringer 95 were slotted to accept the clamp without preloading the duct.
	b. Several areas of corrosion were found on the O_2H_2 burner.	b, c, and d. The conditions were acceptable without rework.
	c. Many areas of corrosion were noted on the stainless steel throughout the 403 external area.	
	d. Oxidation was noted on the LOX and LH_2 low pressure ducts, the LOX chilldown return line, and the tube assembly, P/N 1B75818-1, on the stage side of the customer connect panel.	

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-607-262 9-26-68	After removal of the LOX probe from the stage, a small dent approximately 1/16 inch deep was noted in the Deutsch connector, P/N 1B37872-511, S/N 1410, on wire harness, P/N 1B67152-1, reference location 404W30P6.	The damaged connector was removed and replaced. Retest was accomplished per the PU calibration procedure and PU automatic procedure.
500-607-271 9-26-68	This is a Production requested FARR. Cable assembly, P/N 1B76000, reference location 404W207, was short on branch to plug P47 at panel 404A72A202. The cable should have broken out of main cable at stringer 93, but breakout was at stringer 100. This resulted in the cable being approximately 5 inches too short. The breakout consisted of 16 wires.	The 16 noted wires were removed from the cable and replaced. The cable assembly was tested per 1B76000.
500-607-297 10-11-68	Fuel continuous vent duct assembly, P/N 1B75174-501, S/N 314, was not installed per 1B74943, view M. The 3.74 inch dimension should have been 4.20 $\pm$0.25 inches; also per 1B75174, zone 6, the 3.67 inch dimension should have been 3.75 $\pm$0.03 inches; and per zone 15, the 5.64 inch dimension should have been 5.44 $\pm$0.03 inches. The 12° dimension should have been 10° $\pm$30'.	The duct assembly was removed, reworked, and reidentified per 1B74940-A45-1. The duct assembly was reinstalled and leak checked per 1B71877.
500-607-301 10-14-68	The 404W207 wire harness, P/N 1B76000-1, breakout point to connectors P40, P54, P55, P56, P57, P58, P59, P60, P61, and P63 was at stringer 96 and should have been at stringer 93. This condition caused the harness to be approximately 3 feet too long.	The existing breakout was acceptable to the Material Review Board. The excess length was cut off, and the connectors were reterminated and tested per 1B75537 and 1B55820.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-607-319 10-16-68	During installation of the 404W207 wire harness, P/N 1B76000-1, it was noted that the retro-rocket heat impingement curtain, P/N 1B65109, had ten 3/16 inch bolt holes drilled with blind nuts installed through retainer, P/N 1B65778-515, per 1A39301, zone 14, view J, and should have been NAS nuts per zone 55, view CA for the -503 configuration, stage 1010. NOTE: This condition would not allow the wire harness to be routed through support openings.	The blind nut installation was accepted by the Material Review Board. The 404W207P35 through P39 connectors were removed, and the harness was routed through the support openings. The connectors were reinstalled and tested per 1B75537 and 1B55820
500-607-343 10-22-68	During installation of the fuel mass probe, P/N 1A48431-513, S/N D4, it was noted that brown paper packages of dessicant crystals, with paper masking tape to secure the packages inside the clean polyethylene bag, were used. Also, the bag had several holes near the aft end of the probe.	The exterior of the probe was wiped down with instrument wiping cloths dampened with freon PCA.
500-607-351 11-6-68	The right top of support, P/N 1B37428-513, was broken off where the adhesive attached to the 404A70 panel, P/N 1B51291-507. NOTE: Reference 1B51291, zone 3.	The support was removed by applying heat to a maximum of 300°F. A new support was installed per 1B51291.
500-607-360 10-23-68	During rework per FARR 500-372-575, the area between stringers 66 and 67 was not touched up per DPS 42210. NOTE: This area was located in the center of an ablated coated area.	The surface was cleaned with freon, the rivet heads and exposed doubler were sealed with RTV1200 primer, the surface was treated with treating agent 92-035 and a layer 0.1 to 0.2 inch thickness of 93-044 silicone insulation and feathered into existing flight paint.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-607-459 10-29-68	The 411A90A204 module, P/N 1B42212-1, S/N 017, receptacle J2 pin C was bent.	The pin was straightened per DPS 54002, paragraph 62, and retested per 1B73601.
500-607-467 10-29-68	Connector P24 of the 411W210 wire harness, P/N 1B76064-403, S/N 5242, had a puncture in the environmental seal adjacent to sockets B and C.	Connector P24 was removed, replaced, and tested per 1B73601.
500-607-475 10-29-68	The 411MT753A transducer coaxial receptacle on sensor, P/N 1A68707, S/N 116, was broken.	The sensor was removed. The sensor will be installed and tested at FTC.
500-607-483 10-30-68	During rework per 1A79615 and WRO 4592, it was noted that support assembly, P/N 1B31257-505, between stiffeners 8A and 9 supporting transducer, 403MT709, was distorted due to omitted hardware from a previous installation.	The support assembly was removed and replaced.
500-607-491 10-31-68	During verification of the transducer kit installation, it was noted that aft skirt wire bundle support, P/N 1B62907-69A, installed on the 404A70A1 panel, P/N 1B53666-541, had stripped threads per 1B62907, zone 18.	The support assembly was repaired per 1B53312.
500-607-505 10-31-68	During performance of AO 1B57452BM, the 410MT601B cable assembly, P/N 1B40242-55, S/N 509-15, was badly frayed exposing bare sheilding for an area 2 1/2 feet in length.	The cable assembly was removed and replaced.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-608-285 11-25-68	The following discrepant conditions were found on the common bulkhead during inspection of the LH_2 tank interior a. Five bare areas in the anodizing on the common bulkhead. b. Seven areas of tool chatter marks from 2 1/2 to 20 inches long in the anodizing. c. Insulation tiles number 278 and 325 were loose. d. A 1 inch diameter debond forward of tile No. 10 on the forward dome. e. A crack in the tile around the forward edge of the main diffuser.	All items were acceptable without rework.
500-608-293 11-26-68	During the final acceptance inspection, it was noted that cable assembly, P/N 1B58252-1, was damaged in two places. In both cases, the insulation was cut through to the cable shielding. One of the cuts severed five shield strands.	The damaged insulation was removed above and below the damaged areas, and the broken strands were withdrawn. The area was then overwrapped with 3 layers of DPS 2766 tape, the loose shield strands were then folded back, and a final wrap of 4 layers of tape was applied and fused with a 100 watt soldering iron.
500-608-307 11-26-68	During inspection documentation, it was noted that the LH_2 mass sensing probe, P/N 1A48431-513-009, S/N D4, had no evidence of cleaning per MFSC 164, prior to reinstallation.	The sensing probe was disassembled, routed to the LOX lab, cleaned per DPS 43000-1, and reinstalled. **NOTE:** The system will be leak checked per 1B71877 and functionally checked per 1B55823 at FTC.

TABLE IV (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-608-323 11-29-68	During the performance of the preshipment purge, it was noted that electrical receptacle 404A4J5 had a hole in the rubber insert near pin i.	The Material Review Board accepted the receptacle for use.

APPENDIX III

FLIGHT CRITICAL ITEMS

APPENDIX III

FLIGHT CRITICAL ITEMS INSTALLED AT TURNOVER

The flight critical items (FCI), as designated by DRD 1B53279J, that were installed on the stage at the time of turnover to NASA/STC for shipment to KSC are listed in the following tabulation:

P/N	S/N	Ref. Location	Name
1A48240-505-007	0044	404A7	Fill and drain valve
1A48240-505-007	0127	427A8	Fill and drain valve
1A48257-525	0068	411A1	LH_2 vent and relief valve
1A48312-513	0051	424A1	LOX vent and relief valve
1A48430-509-011	D9	406A1	LOX mass probe
1A48431-513-009	D4	408A1	LH_2 mass probe
1A48857-501	43	403A73	Control helium tank
1A48858-1	1012	Bnk 2 Pos 9	Helium sphere, cold
1A48858-1	1127	Bnk 1 Pos 3	Helium sphere, cold
1A48858-1	1132	Bnk 2 Pos 8	Helium sphere, cold
1A48858-1	1139	Bnk 1 Pos 4	Helium sphere, cold
1A48858-1	1146	Bnk 2 Pos 7	Helium sphere, cold
1A48858-1	1160	Bnk 1 Pos 5	Helium sphere, cold
1A48858-1	1161	Bnk 1 Pos 2	Helium sphere, cold
1A48858-1	1164	Bnk 1 Pos 1	Helium sphere, cold
1A48858-1	1167	Bnk 2 Pos 10	Helium sphere, cold
1A49421-507	207	427A3	LH_2 aux chilldown pump
1A49423-509	1388	424A4	LOX aux chilldown pump
1A49964-501	222	424 (LOX)	Chill system check valve
1A49964-501	265	427 (LH_2)	Chill system check valve
1A49965-523-012	0506	424A41	Chill system shutoff valve
1A49965-525-013B	0507	424A4	Chill system shutoff valve
1A49968-519	123	404A44	Prop. tank shutoff valve
1A49968-521	150	424A6	Prop. tank shutoff valve
1A49988-513	0036	411A29	LH_2 directional vent valve
1A49991-1	047	403A74	Tank, comp. gas, cold helium
1A49991-1	58	403A6	Tank, comp. gas, cold helium
1A57350-507	0232	403A73A13	Helium fill module
1A58345-523	1034	403A73A1	Module, pneumatic pwr control
1A58347-513	05	403A75A2	Engine pump prg cont mod
1A59358-525	00004	411A92A6	PU electronics assembly
1A66212-507	025	411A92A7	Inv-conv elect. assy
1A66240-503	X457808	401A11S1, S2	Engine driven pump, hydraulic
1A66241-511	X454588	403B1	Aux hydraulic pump
1A66248-505-011A	51	403A71L1	Hydraulic actuator assy
1A66248-505-011A	53	403A72L1	Hydraulic actuator assy
1A68085-505	0108	411A99A10A1	300 amp pwr transfer switch

Appendix III (Continued)

P/N	S/N	Ref. Location	Name
1A68085-505	0098	404A45A1	300 amp pwr transfer switch
1A68085-505	0101	404A2A1	300 amp pwr transfer switch
1A74039-517-011E	00037	404A74A2	Chilldown inv. elect. assy
1A74039-517-011E	00039	404A74A1	Chilldown inv. elect. assy
1A74211-505	0424	404A2A6	2 amp relay module
1A74216-503	0465	411A99A10A6	Mag latch relay module
1A74216-503	0488	404A45A5	Mag latch relay module
1A74218-505	0490	404A2A2	10 amp relay module
1A74765-507	224	401A11S1	Hyd syst thermal switch
1A74890-501	0121	404A2A7	50 amp relay module
1A74890-501	00117	404A45A2	50 amp relay module
1A74890-501	0124	404A2A10	50 amp relay module
1A74890-501	0125	411A99A10A2	50 amp relay module
1A74890-501	0123	404A2A9	50 amp relay module
1A77310-503.1	0103	411A98A2	5 volt excitation module
1A77310-503.1	0170	411A99A33	5 volt excitation module
1A77310-503.1	0171	404A52A200	5 volt excitation module
1A86847-509	059	401A11S1, S2	Hyd pump thermal isol assy
1B29319-519	00034	403A46	Accum/reservoir assy
1B32647-505	068	404A45A3	Hyd pwr unit start switch
1B33084-503	013	411A97A19	RS controller assy
1B33084-503	014	411A97A13	RS controller assy
1B39037-501	4	401	Eng installation bolts
1B39037-501	32	401	Eng installation bolts
1B39037-501	57	401	Eng installation bolts
1B39037-501	202	401	Eng installation bolts
1B39037-501	203	401	Eng installation bolts
1B39037-501	204	401	Eng installation bolts
1B39550-515	009	404A3	Sequencer mounting assy
1B39975-501	0237	404A2A16	Diode module
1B39975-501	0239	404A2A17	Diode module
1B40604-1.2	083	404A2A34	Diode assy module
1B40604-1.2	051	404A2A18	Diode assy module
1B40604-1.2	0110	404A3A51	Diode assy module
1B40604-1.2	0113	404A3A50	Diode assy module
1B40824-507.1	110	403 Str 9A	Check valve
1B40824-507.1	108	403 Str 9-3/4	Check valve
1B40824-507.1	126	403 Str 6A	Check valve
1B40824-507.1	117	403A74A4	Check valve
1B40887-501	0291	404A2A15	10 amp mag latch relay mod
1B40887-501	0306	404A45A6	10 amp mag latch relay mod
1B40887-501	0259	411A99A10A4	10 amp mag latch relay mod
1B40887-501	0213	411A99A10A5	10 amp mag latch relay mod
1B40887-501	0305	404A3A16	10 amp mag latch relay mod
1B40887-501	0354	404A3A57	10 amp mag latch relay mod
1B40887-501	0556	404A3A58	10 amp mag latch relay mod

Appendix III (Continued)

P/N	S/N	Ref. Location	Name
1B42290-507	0043	403A74A1	LOX press. control module
1B51211-505	011	404A45	Aft 56 volt pwr dist assy
1B51354-507	09	404A2	Aft 28 volt pwr dist assy
1B51379-511	08	411A99A10	Fwd pwr dist mount assy
1B51753-511	026	411A32	LH_2 prop vent reg & S/D valve
1B52623-515	008	403S2	Pressure switch
1B52624-511	035	411S2	Pressure switch
1B52624-511	025	411S4	Pressure switch
1B52624-515	26	403S8	Pressure switch
1B52624-519	44	403S1	Pressure switch
1B52624-519	51	403S5	Pressure switch
1B52624-519	52	403S6	Pressure switch
1B53920-501	037	403A73	Chill feed duct check valve
1B53920-503	047	LOX C/D duct	Chill feed duct check valve
1B53920-503	070	LH_2 C/D duct	Chill feed duct check valve
1B55408-503	00018	Str 13-14	Compressed air tank
1B57731-501	417	404A71A19	Control relay package
1B57731-501	418	404A51A4	Control relay package
1B57781-507	027	403A74A2	Cold helium fill module
1B58006-401	47	403A74	1A49991, teflon wrapped
1B59010-509	125	427A7	Pneu prop. control valve
1B62600-527-012	08	403 Str 10-3/4	O_2H_2 welded burner assy
1B62778-503	00008	403A7	Helium plenum & valve assy
1B62778-503	024	403A6	Helium plenum & valve assy
1B65319-503	013	404A70A1	Sw sel emissivity cont assy
1B65673-1	23	403A13 Str 6	Cold helium check valve
1B66230-509	1034	403A73A3	Calibrated LH_2 press. cont mod
1B66639-515	46	403	Pneu latching actuator assy
1B66639-519	032	411A32	Pneu latching actuator assy
1B66692-501-A45-1	27	404A44	Actuation control module
1B66692-501-A45-1	25	404A43	Actuation control module
1B66692-501-A45-1	84	403A15	Actuation control module
1B66692-501-A45-1	35	411A30	Actuation control module
1B66692-501-A45-1	85	404A17	Actuation control module
1B66692-501-A45-1	24	403A75A1	Actuation control module
1B66692-501-A45-1	26	404A9	Actuation control module
1B66692-501-A45-1	33	411A2	Actuation control module
1B66692-501-A45-1	32	411A3	Actuation control module
1B66692-501	151	403A8	Actuation control module
1B66692-501	169	411A14	Actuation control module
1B66868-501	09	Pos 8 Str 20	Ambient helium sphere
1B66868-501	10	Pos 9 Str 23	Ambient helium sphere
1B66868-501	011	Pos 10 Str 24A	Ambient helium sphere
1B66868-501	013	Pos 1 Str 6A	Ambient helium sphere
1B66868-501	014	Pos 2 Str 7A	Ambient helium sphere
1B66868-501	016	Pos 7 Str 18	Ambient helium sphere
1B66868-501	017	Pos 6 Str 17	Ambient helium sphere
1B66868-501	019	Pos 5 Str 12	Ambient helium sphere

Appendix III (Continued)

P/N	S/N	Ref. Location	Name
1B67193-511	044	411A32	Continuous vent control mod
1B67481-1	804159	411A14L2	Check valve, 1/4" vent port
1B67481-1	804158	411A14L1	Check valve, 1/4" vent port
1B67481-1	70621101	411A3L1	Check valve, 1/4" vent port
1B67481-1	70621102	403A15L2	Check valve, 1/4" vent port
1B67481-1	70621116	404A44L2	Check valve, 1/4" vent port
1B67481-1	70621143	404A17L1	Check valve, 1/4" vent port
1B67481-1	70621147	403A75A1L2	Check valve, 1/4" vent port
1B67481-1	70621173	411A2L2	Check valve, 1/4" vent port
1B67481-1	70621195	403A74A1	Check valve, 1/4" vent port
1B67481-1	70621196	404A17L2	Check valve, 1/4" vent port
1B67481-1	70621208	404A44L1	Check valve, 1/4" vent port
1B67481-1	70621209	404A43L1	Check valve, 1/4" vent port
1B67481-1	70621214	403A75A1L1	Check valve, 1/4" vent port
1B67481-1	70621256	403A8L1	Check valve, 1/4" vent port
1B67481-1	70621279	403A8L2	Check valve, 1/4" vent port
1B67481-1	70621300	403 Str 20	Check valve, 1/4" vent port
1B67481-1	7062133	403A74A2L1	Check valve, 1/4" vent port
1B67481-1	7062153	404A9L1	Check valve, 1/4" vent port
1B67481-1	7062156	411A3L2	Check valve, 1/4" vent port
1B67481-1	7062160	403A15L1	Check valve, 1/4" vent port
1B67481-1	7062165	411A30L2	Check valve, 1/4" vent port
1B67481-1	7062173	411A30L1	Check valve, 1/4" vent port
1B67481-1	7062174	404A9L2	Check valve, 1/4" vent port
1B67481-1	7062189	404A43L2	Check valve, 1/4" vent port
1B67481-1	7062191	411A2L1	Check valve, 1/4" vent port
1B67481-1	8010550	403A73A1L1	Check valve, 1/4" vent port
1B67481-1	8082835	403A74A2	Check valve, 1/4" vent port
1B67598-501	104	403 Str 6	Pneumatic check valve
1B67598-501	105	403 Str 18	Pneumatic check valve
1B67598-501	106	404 Str 28A	Pneumatic check valve
1B67598-501	107	LOX F&D	Pneumatic check valve
1B67598-501	110	403A73A4	Pneumatic check valve
1B67598-501	126	LH_2 F&D	Pneumatic check valve
1B67598-503	73	--	Pneumatic check valve
1B69030-501	0022	424A9	LOX NPV control valve
1B69514-501	07	404A3A56	Isolation diode module
1B69514-501	09	404A9	Isolation diode module
1B69514-501	011	404A11	Isolation diode module
1B69514-501	021	411A99A8	Isolation diode module
1B69514-501	031	404A3A55	Isolation diode module
1B69550-501	031	403A73A4	Repress. control module
1B69550-501	030	403A74A3	Repress. control module

Appendix III (Continued)

P/N	S/N	Ref. Location	Name
7851823-503	1060	Pos 2 at umb	Helium control disconnect
7851823-503	1084	Pos 1 at umb	Helium control disconnect
7851844-501	62	10" from F&D	Cold helium disconnect
7851861-1	57	427	LH_2 tank press. disconnect
40M39515-113	277	404A75A1	EBW firing unit
40M39515-113	283	404A75A2	EBW firing unit
40M39515-113	282	404A47A2	EBW firing unit
40M39515-113	285	404A47A1	EBW firing unit
40M39515-119	451	411A99A12	EBW firing unit
40M39515-119	450	411A99A20	EBW firing unit
103826	J-2091	401	J-2 engine